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REASONS WHY PRICES ARE LOW.

By Albert Williams, Jr.

SOME one wrote long ago that there could be no such thing as over-production, meaning that there could not be too much of the good things of the earth,—that the trouble is that would-be consumers cannot obtain them. This may be all very well as an abstract proposition, but as an explanation for prevailing low prices it will hardly be deemed satisfactory by the producers and holders of the many staples which have fallen greatly. Such a statement has an attractive sound for those who prefer a striking generalization to a plain presentation of facts.

Various reasons, more or less plausible, have been adduced to account for the existing condition of things. On the whole, taking a long list of commodities of all sorts, it is apparent that the average scale has been far lower of late than in former years, but that in the case of a few items there has been an advance; and it will be found that in these exceptions is the real key to the situation. Among the specific causes for a decline in certain cases one—"hard times"—is evidently no reason at all, being about on a par with the children's argument, "because." To give a name to a fact, an event, or a condition, is not to ascertain its origin. Another reason offered is legislation; but, admitting that this has an effect in some directions, it will hardly be claimed that it applies in all or in very many.

The one great economic law of universal application is that of supply and demand. It is as firmly established as the law of gravitation. To advance it at this late day is to put forth an accepted truism; but to clearly understand its workings it is necessary to have in mind a clear definition of supply, demand, production, consumption, and similar terms, and to allow for the modifications which distance, time, cost of transportation and exchange, and also, sometimes, tariff and

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currency legislation bring in, thus tending to obscure the main underlying issue and make the whole subject seem more complicated than it really is. For that matter, if we should clear away these minor factors, it might be found that the one central law explains about nine-tenths of economic phenomena, and that the lesser disturbing factors taken altogether may be responsible for the other tenth.

The law is absolute, inflexible. But its operation is not immediate. Water seeks its level, but it requires time to reach it. So also prices ultimately reach their level, but the process takes time in overcoming local and temporary obstructions, and hence the results are not quite concurrent; by the time a balance is established between supplies and rates at one place far distant from another, a further movement at the starting point again slightly disarranges the balance. It is very noteworthy that the earlier economists of the modern school had a vision so penetrating as not to be misled by apparent discrepancies. This is especially remarkable when it is remembered that, when the law was enunciated, the means of distribution were crude and imperfect as compared with those of to-day. Without railways and steamships, which meant that transportation across the North Atlantic occupied from three weeks upward, and that inland traffic was even more backward; without the Suez canal and its relatively short route between the Orient and Europe; without hundreds of modern facilities for moving and exchanging goods,—there were not only delays and added costs, but there were much larger local differences than at present. Even with quicker and cheaper transportation by sea and land and inland waters, these discrepancies still exist, but in far less degree. The rapid dissemination of intelligence by land-telegraph and cable, and for shorter distances by telephone, and the vastly-improved mail and express service, place all the important markets of the world in close touch; and these latter facilities are at least as influential as better methods of moving freights. There are also improved methods of transacting business, simpler and more expeditious; and international clearing-houses, with possibly uniform money units, will still further reduce local differences.

Practically, if not quite absolutely, the world is *one* in a commercial sense. Or, if allowance is made for all disturbing factors, this might be stated as an underlying law parallel with and explaining that of supply and demand. The commercial centers thrill in unison. A vibration in the London or Manchester cotton market is transmitted instantly to Charleston, New Orleans, Galveston, Alexandria, and wherever cotton is handled in quantity. There is also a reflex effect, beginning at each shipping-point and focusing in England, and affecting in turn every single market, until a balance is struck which would

exhibit identical figures for equal grades everywhere, were it not for freights, commissions, differences in exchange, and so on. So it is with every staple of universal use.

But there are other influences that sometimes come into action. Among these are currency legislation, tariff legislation, reciprocity treaties, commercial retaliation, local prejudices, etc. Their combined effect is probably over-estimated, but they are made much of by the few who try to belittle the main economic law. In one instance a sharp controversy has been waged for some years. It is over the price of silver. Gold monometalists assert that, while adverse legislation has affected the price, this legislation was enacted because of the alarmingly increasing production. Silver men assert that legislation alone is to blame; that the old ratio to gold could have been maintained, had not legislators become timid. The question is of a somewhat circular nature, and much depends upon the direction in which one goes. But, without going into its merits here, it may be well to reproduce a table published in the December issue of this magazine:

WORLD'S OUTPUT OF SILVER AND ITS COMMERCIAL RATIO TO GOLD.

	Production: Troy Ounces.	Ratio.		Production: Troy Ounces.	Ratio.
1873	63,267,000	15.92	1884	81,597,000	18.57
1874	55,300,000	16.17	1885	91,652,000	19.41
1875	62,262,000	16.59	1886	93,276,000	20.78
1876	67,753,000	17.88	1887	96,124,000	21.13
1877	62,648,000	17.22	1888	108,827,000	21.99
1878	73,476,000	17.94	1889	120,214,000	22.10
1879	24,250,000	18.40	1890	126,095,000	19.76
1880	74,791,000	18.05	1891	137,171,000	20.92
1881	78,890,000	18.16	1892	152,940,000	23.72
1882	86,470,000	18.19	1893	161,163,000	26.49
1883	89,177,000	18.64			

Commercial legislation may take the form of an import duty, an export duty, or bounties, complicated with discrimination for or against the products of particular countries. In the somewhat acrimonious debates over tariff matters in congress tons of statistics have been brought forward on different sides and over special items, among which wool and sugar have been especially prominent. The wool question has been complicated by the requirements of manufacturers for certain grades not produced in the United States, and also by the demand for cheaper woolen goods, which are now very low. That tariffs high or low, or no tariff, have a positive effect on local prices is unquestioned; but the effect is often not at all what was expected. In order to intelligently discuss such intricate questions, it would be necessary to have exact statistics for the whole world, concerning a given commodity, in order to trace the movement of the product, the prices at all centers, and the influence of freight rates and many minor factors.

This cannot be done in detail here, but the assertion may be ventured that nothing has yet been shown to detract from the preponderating effect of the main economic law. However, a few figures here and there may be of interest in lieu of more complete statistics.

Wheat is one example of overproduction, in the sense that, while people in some places may be suffering for flour, it has been a poor crop for the producer. It is well known that production and visible supplies had been increasing rapidly for some time, and in December last it was anticipated that total stocks would again be larger at the January statement than in the previous year; but *Bradstreet's* final figures show that, while there were increased stocks in the United States and Canada of 17,000,000 bushels more than one year ago, 11,000,000 more than two years ago, and 49,000,000 more than three years ago, the falling-off from 1894 in European stocks was 22,200,000 bushels. This slight difference does not controvert the fact that, on the whole, the production for a series of years has enormously increased. Meanwhile the prices of No. 2 red winter wheat in New York have been: in 1892 (average), 90¾ cents per bushel; in 1893, 73⅞ cents; in 1894, 61⅛ cents. These figures correspond with the drop in foreign markets. The simple fact is that wheat has been overproduced. It is raised over vast new areas in Argentina, Australia, and India, to say nothing of former sources.

Cotton is another staple that has been overdone. The acreage has been greatly increased, and with the corresponding augmented yield the price has been falling. Of late the change has not been so marked as that shown by comparison with the years when 12 cents and over was a common rate. In 1892 middling uplands at New York ranged from 6 11/16 to 8¼ cents; in 1893 this grade was quoted at 7 13/16 to 9¾ cents,—a small gain; but in 1894 the average lowest to average highest quotations were 6 5/16 to 8¼ cents. Statistics published by the *Commercial and Financial Chronicle* show that the total receipts of American cotton from September 1, 1894, to the close of the year (that is, since the end of the last season) were 5,096,098 bales, against 4,157,260 in the same period of 1893.

Iron and steel have also fallen to the lowest prices on record. At the beginning of 1894 No. 1 anthracite was $14 a ton; at the opening of 1895 it was $12, with other grades in proportion. The present rate of production is about 50 per cent. greater than a year ago.

Corn has been fairly steady, ranging from 54 cents in 1892, 49 15/16 in 1893, and 50 15/16 in 1894, when the failure of the crop in parts of Kansas and Nebraska stiffened prices somewhat.

Mess pork sold in New York at $11.52 as an average for 1892; at $18.35 in 1893; at $14.13 in 1894; and in the first week of January

it sold up to $14.50. Beef is another of the provisions that has advanced in the face of the general lowering of prices. It averaged $6.86 at New York during 1892, $8.19 for 1893, and $8.16 for 1894. In the case of both these products the supplies in domestic markets have been lessening.

Flour has naturally followed wheat downward; wool also shows a large decline. The provisions exhibit little change. Petroleum is a somewhat erratic product, and in this instance has risen against the general markets. If it were possible to quote accurate figures for the world's production of these and other products at this early period in the year, the relation between production and price would come out plainly. As it is, the general impression as to the several products is in harmony with the law.

A curious set of facts in support of a belief in the infallibility of the law of supply and demand is furnished by the operations of trusts, pools, and "combines." At first glance this might not seem to be so, for the object of such combinations is to control the markets and hold prices at a profitable point, or rather at a point as high as consumers will stand. Yet these attempts, if intelligently engineered, really do nothing more than restrict production, or, less frequently, widen markets,—that is, effect artificially what would in the long run occur in any event; and, if planned without foresight, they antagonize natural laws. These attempts to regulate prices are usually more or less successful at first, and sometimes continue to be so for a long while, if the commercial ability of the managers is great and the loyalty of the members of a pool of producers is steadfast, and also if the management has such a firm grasp upon the situation that it can force the members to keep strictly within the rates or quotas that have been determined upon. If the stocks with which such an organization operates are small, prices can be held up pretty stiffly in the case of any commodity of general and necessary use; if the stocks begun with are small, but are allowed to increase beyond limits, then at first the movement will be successful, but it will soon collapse: if at any time the stocks held are large, it may be possible to maintain prices for a time, or so long as the original policy is adhered to, by selling only a certain small portion and holding the rest firmly; but the mere knowledge on the part of consumers that there are such large reserves will cause them to hold back, and will generally defeat the object of the pool in the case of all commodities, and certainly will if the goods in question can be done without for a season. An example of continuously skilful management on the part of a monopoly is furnished by the Standard Oil Company, which, no matter how much berated, has always had the good judgment to keep within bounds and not

kill the goose that lays the golden eggs. An extreme case of flighty management was presented by the tin combine a few years ago, which forced prices to an exorbitant pitch for a short time, but, having large known stocks on hand and attempting to realize rapidly, broke the market with a stunning crash the moment large lots were offered for sale. It is impossible to artificially regulate production in the majority of cases, because the supply is too large, the producers too numerous to be controlled, or the demand too uncertain. In such instances, in the natural course of events, things shortly find a level, for the law is automatic as well as axiomatic. When prices fall so low that there is no profit in production, the producers gradually drop off,—the weaker ones first,—and prices begin to rise. When prices rise so high that there is a profit much beyond current interest rates, new producers come in, and old ones increase their capacity and output to the best of their ability, until production runs ahead of consumption, holders are forced to sell, producer and production fall off, and everything comes again to a normal equilibrium.

"Corners" are of a different order. They are attempts to control large visible supplies by cash purchases and futures or options. They fail oftener than they succeed, for the profits temporarily made are likely to be utterly swamped when the corner goes to pieces—as sooner or later it must inevitably.

The number and amount of business failures are valuable indices of the state of trade. In 1894, according to *Bradstreet's* reports, the number of failures in the United States was 12,721, as compared with 15,560 in the panic year 1893,—the greatest number ever reported: but a better showing is made by the total volume of indebtedness, which was only $140,505,000 in 1894, or about 37 per cent. less than in 1893, while the shrinkage in number of failures was 18 per cent. These figures show that, while trade is still dull, it is on a much sounder basis than in 1893. In the cases where prices have declined since 1893 the fall cannot be ascribed to any fresh panicky feeling, but must be due to some other cause.

Another symptom of the condition of trade is afforded by comparative statistics of bank clearings. In 1894 the total clearings at thirty-five cities of the United States were $44,993,611,293, or 16 per cent. less than in 1893, and 27 per cent. less than in 1892, in which year the largest total was recorded. The total for 1894 was the lowest for nine years. In 1894, and also in 1885, the shrinkage followed upon a year of panic. The decrease is not an unhealthy sign, being due to the slowness with which trade recovers from a collapse. In fact, during times of commercial disaster there may be heavy clearings, due to the efforts to realize and to adjust balances. The heavy

decrease in bank clearings last year simply means that trade was dull and transactions curtailed. For the current year it is anticipated that the figures will begin to increase again.

It is noticeable that improvements in volume of business and in prices are always (leaving out of consideration for the moment artificial and sporadic upheavals caused by corners, trusts, and pools) much more gradual than the declines, but are accompanied with small, though sharp, intervening downward reactions brought about by speculators who have got in on a lower plane realizing on their holdings. Producers gradually regain confidence after a commercial shock, and increase their output wherever the demand permits, while merchants slowly extend their operations and increase their stock-in-trade, and consumers at large begin to add to their consumption. This course of affairs progresses with the gentle ascents and small downward jogs which can well be shown by an ideal graphic chart. This generalization is not local to any one country or community, but must take into account reciprocal foreign influences, which become more potent year by year as international monetary and commercial relations become more closely interwoven.

The last ascent, reaching up to the maximum "boom" point, is usually steeper than the earlier ones. When the decline begins, it may for a short time be gradual, but soon it becomes precipitous, though with small upward reactions in the speculative world, caused by the covering of shorts in the stock market and by corresponding actions in other business, and also by spasmodic investments prompted by the belief that bottom has been touched. Then there is a long pause, a slow readjustment of values, and a virtual repetition of commercial history. Although speculation is here mentioned, the statement concerning it is made in a general sense. Nothing in it collides with the law of supply and demand, or with the volume of production or widening of markets. The natural law continues to operate, while the temper of the commercial world at any given time, the prevalent feeling and opinion as to the immediate outlook, are both affected by the natural adjustments, and, on the other hand, tend to stimulate or depress production and demand. Men, after all, are somewhat like sheep. Their ovine instinct is irrepressible. It takes a very slight impulse to set the flock in motion—savings-bank depositors, tradesmen, consumers, producers, legislators, even the coolest-headed financiers. All are alike in kind, if not in degree. The apparent exceptions prove the rule. Indeed when the general temper becomes nervous and susceptible to alarms, and the public is evidently on the verge of a panic, those who do keep their wits, realizing that a stampede is imminent, take precautionary measures, and thus hasten and

precipitate the crash which they would not of their own motion cause, but which they are powerless to avert. This is seen at the beginning of every run on a bank. Men who believe in the stability of the bank and the ultimate safety of their money may not be afraid of the bank, but of the crowd of impulsive small depositors. They therefore get out ahead of the rush, in order to avoid being tied up. This makes matters worse.

There is a saying that panics are to be expected about once every twenty years in this country. The dates 1837, 1857, 1873, 1893 seem to bear out this belief, and in turn the belief reacts on all business. A speculator, a corporation, anyone, would be pretty safe in shaping his general policy by some such rule. This recurrence is a phenomenon comparable in the regularity of its working with the statistics of suicide and crime. It seems to require just about this length of time for public opinion in commercial matters to swing through a certain cycle—from dullness to slow access of activity; to brisk trade, larger production and consumption, fair prices; to implicit faith that good times are to last indefinitely; to extension of credits; to the boom pitch; then hesitation, mistrust, contraction; a sudden loss of all confidence, and a slump in all values corresponding with this unreasoning state of mind. Public opinion cannot be regarded quite as though it were individual opinion on a large scale, for the commercial public of any time is made up of units different from those of an epoch twenty years earlier. If it does not learn by experience, on the other hand it forgets; its memory is hardly capable of reaching back so far. Besides the concrete causes of panics or of revivals, this human weakness cannot be ignored.

The proximate causes of panics, the only ones which superficial observation discovers, are too various and too contradictory to be the real ones. Inflation and reaction in 1893; residual effects of the Baring-Argentine collapse; tight money market; fears of pro-silver and low-tariff legislation in 1893,—these are but incidents, excuses. The true cause lies deeper. It is in the great economic law working mechanically, and incidentally effecting psychologic events.

The next generation may look out for a panic about 1913. In the interim there will be serious backsets, but on the whole the course of business should be progressively better.

THE RAILROAD OF THE FUTURE.

By Theodore Voorhees.

AS we ride in the well-appointed train of to-day, over the smooth track, and consider the various appliances that minister to the comfort of our journey, it is difficult to recall the railroad as it was but thirty years ago, so great and numerous have been the changes.

Thirty years ago our railroads were laid with light iron rails on a track ill-ballasted with ashes or gravel; of sub-drainage one hardly ever heard, and even the ditches were but poor and usually choked with *débris* and weeds. The rails were connected by a short chair of cast iron, which seldom remained firm over twenty-four hours at a time. The passage of the wheels over these loose joints caused the "click-y-ti-click," or song of the train, which was then the invariable accompaniment of a journey. The train that passed over this track would to-day seem well-nigh as crude. The locomotive resplendent in bright brass and paint was, it is true, more attractive to the eye than its successor. But in power how inferior! It usually burned wood, and it always threw sparks, to the detriment, not only of the passengers' eyes and clothing, but of the passing fences and fields as well. Then the cars: light, low, uncomfortable; with small windows and no ventilation; heated in most cases by cast-iron stoves that burned wood, and that were usually red-hot. The passengers suffered torture from the hot air about their heads and the cold draughts about their feet. These cars were coupled by a link and pins, so that stopping or starting the train violently jolted every one in it. Air-brakes were not known. If the engineer had cause to anticipate danger, which was not infrequent, he "blew for brakes," which signal caused the trainmen to dash wildly to the platforms, and at the same time thoroughly alarmed all the passengers.

The first sleeping-cars were beginning to be talked about as a novelty; as for parlor-cars, there were scarcely any in use. Perhaps nothing more clearly emphasizes the difference in the comfort in travel between the present day and thirty years ago than the entire disappearance of the American duster. In those days no one thought of undertaking a journey without that useful but unsightly garment. To-day one can hardly be found for sale.

Turning from that picture to the present, let us briefly consider a few of the changes we have seen during the past thirty years. First, as to track. In place of the light iron rail poorly fastened, we have

to-day substantial steel rails of eighty, ninety, or one hundred pounds' weight to the yard. These are so secured to the ties and to one another that the roadbed affords a smooth and unyielding track for the heaviest trains. The roadbed itself is in most cases thoroughly drained and ballasted with broken stone, is well policed, and presents a neat and attractive sight to the travelers. Next, the trains. It would seem as though ingenuity had been exhausted in providing for the comfort and convenience of the passenger. We now have ample space to sit or move about; comfortable sleeping-cars, with absolute privacy for every purpose; dining-cars, observation-cars, reading-rooms; every appointment, in fact, of a first-class hotel, upon wheels. Then of special cars for special purposes there is no end. Mail-cars of different styles and plans, each suited to its particular use; hunting-cars for sportsmen; tourist sleeping-cars; and even funeral-cars, arranged expressly for funeral parties and used for no other purpose.

Nor has all the improvement been in the passenger service. Equal and possibly even greater advances have been made in the movement of freight. Thirty years ago many roads were distinct and independent of each other, and joined, if at all, with their connections by inconvenient means. Many lines that are now through-routes under a single management were disjointed, and required awkward transfers at terminal points. The journey between New York and Washington involved a tedious transfer by horse-car both in Philadelphia and Baltimore. A similar state of things existed as to freight. Many roads would not permit their freight-cars to go beyond their own lines, so that all freight destined to points beyond had to be transferred from car to car at the junction, involving delay and often damage. To-day this is well-nigh unknown. Passengers and freight are taken across the continent, or from north to south, without the necessity of change or break of bulk.

While these improvements have been taking place in the character of our tracks and trains, the safety of the service has also greatly improved. Perhaps nothing has done so much for this as the invention of the air-brake, for which, and for whose present perfection, the public owes so much to Mr. George Westinghouse, Jr. A train that in the old days of hand-brakes would often run half a mile before it could be stopped can now be stopped inside of its own length. Next to the air-brake, as a safety appliance, should be mentioned the block system. This, in various forms, is rapidly coming into use to-day, and, wherever used, it amply repays its cost in the immunity from accident which follows.

It is but a little over sixty years since the first railway was built in America. It is within the active lifetime of many men engaged in

railway service to-day that the changes briefly sketched above have taken place. What will our railway be when it shall have completed its first century of life? What changes will the next generation see? No doubt the railway of to-day will seem as poor to our children as that of our boyhood does to us.

He would be a brave man who would venture to describe the railway of the twentieth century. But one may venture some suggestions as to the needs of the present, and in this way perhaps form an opinion as to the possibilities of the future. Let us consider, first, the roadbed and permanent way. As already stated, great improvements have been made in this respect during the past few years. At the same time we are still using the wooden tie and wrought-iron spike, practically the same as those used thirty years ago. Too much dependence, in the writer's opinion, seems to be placed on the weight and stiffness of the rail, and not sufficient attention paid to the fastening of the rail to the ties. Accidents due to this defect are not unknown even on well-managed railways. It is true, various companies are experimenting with steel ties and with clamps, bolts, and other fastenings to remedy this evil, but so far none can be said to command entire approval. No doubt the end will soon be accomplished, and before many years the wooden tie and short spike will disappear from our tracks. It goes without saying that, in the construction of the railway of the future, wooden structures, such as culverts, trestles, and bridges, will not be permitted. Openings of any sort in the surface of the roadbed ought not to exist. In this connection one improvement, already coming into quite extensive use, may be mentioned: the floor of all bridges, large or small, through or deck, should be solid and so arranged as to permit the deposit upon it of the usual ballast and track. Great safety, both to bridge and train, ensues from such a construction in case of possible derailment.

Grade-crossings must be abolished! When our railways were first built, and in fact in many cases where they have been but recently built, little attention was paid to the question of grade-crossings. The whole aim has been to build expeditiously and cheaply, so that the transportation of passengers and freight may begin, often leaving the real construction to be paid for out of future earnings.

The roads, in turn, have stimulated the building of towns along their lines. Many places that were green fields adjacent to the railways are now populous towns and cities. The inhabitants have built dwellings, stores, and factories immediately fronting on the railway, so that the original right of way oftentimes becomes a public street, intersected by numerous crossings. This process can be seen in almost every considerable town in the country. It is still going on in every

direction. With the growth of population follows an increase of traffic. This in turn increases the dangers of the grade-crossing. Then a struggle ensues between the public, demanding safety and the abolition of all crossings at grade, and the railway companies, whose roads in many cases were the origin of the growth of the locality, and whose revenues will not warrant the total reconstruction usually required to remedy the evil.

The present rapid multiplication of trolley-lines is increasing greatly the dangers of the grade-crossing. Competition with steam-lines for suburban traffic is so keen that the trolley-lines run at high rates of speed. In consequence, accidents through failure to properly control the cars at crossings are not infrequent, and this lack of control may be said to have distinctly increased the danger to the public from all such crossings. Municipalities are very generally recognizing these facts, and in many directions plans are taking shape looking to the total abolition of all crossings at grade. Of almost equal importance are the arrangement and construction of the stations. They should be so planned as to make it unnecessary for any passenger to walk upon or across the tracks. The American public is self-reliant, accustomed to taking care of itself, and invariably rebellious against the introduction of gates, fences, foot-bridges, or tunnels intended for the safety of passengers. But at the same time it demands high speed, safety, and punctuality, and it must in time conform to such wise regulations and arrangements as will insure the passage of all trains without the possibility of loss of life or limb.

Another problem for the future will be the abolition of grade-crossings of one road with another, or of branch lines connecting with a main stem. The difficulties presented by this problem will often be harder to overcome than those presented by the highway crossing. The cost, too, will fall wholly on the corporations. The risk is there, however, and ultimately the difficulties and cost must be met.

That our roads should be equipped with absolutely reliable signaling apparatus is acknowledged by all to-day. That this, as well as the proper interlocking of all switches, will be universally realized in future there can be no doubt. With a railroad thus equipped, it will be possible to start a train at speed at one terminus and not slacken or reduce speed until the end of the trip. It may be urged that this is done on many lines to-day. True, but it is in no case done without a certain risk. It often involves considerable risk, not perhaps to the passengers in the train, but certainly to the public on highway crossings and to trespassers and others on the tracks. But what of our trains? Have we reached the limit of improvement? Compared with what they were thirty years ago, the advance seems marvelous.

Will this continue? It is difficult to reply, and yet the writer believes that increasing efficiency and progress will be made in this direction as in others. The public demands high speed. A continuous speed of a mile each minute is no longer unusual. Why should not this be excelled in future? An engine is running to-day that has moved a train a mile in thirty-six seconds,—a rate of one hundred miles an hour. With improved track, no obstructions, no possibility of collision, and an alignment free from sharp curves, one hundred miles an hour ought to be as easy of accomplishment as sixty is to-day. At such high speed the resistance of the air, especially in case of storm or head wind, will no doubt be the chief obstacle to overcome. Very possibly the railway train of the future will be planned with this in view. The lines of the train will be calculated for wind resistance very much as those of a yacht are to-day for the resistance of the sea.

When one considers the wonderful growth in the use of electricity during the past thirty years, it is impossible to say to what uses we may put it in the near future. The electric light and the telephone are familiar in every village. The trolley car is rapidly extending its journeys so that soon it will pass each farmer's door. The steam railways are in some cases lighting their cars with incandescent lamps. Electricity is used for heating cars. At Baltimore an electric plant is rapidly approaching completion that is to provide power for an electric motor of sufficient capacity to move heavy trains through a tunnel half a mile in length. If this can be accomplished, may we not expect to see electricity ultimately supersede steam as the motive power of the locomotive? It will not do to declare it impossible; and yet it is very questionable if it will come in the near future. Electric lighting of passenger trains will doubtless come into general use as soon as a practical and reliable method is devised of generating the power from the axle of the car-truck. But the expense involved in generating electricity in quantities sufficient to exercise a power equal to that of a first-class locomotive is so great that its use is at present impracticable. Possibly the future may develop some plan of drawing power directly from the rays of the sun. If, then, this power can be transferred into electricity and stored, there will ensue a revolution as great as when Watt first discovered steam. Then power will be limited, not by the cost and production of coal, but by the number of days of sunshine each year, and transportation will be brought within the means of all.

We have seen great changes in the construction of our railways, wonderful improvements in the building of our trains, increased speed, increased comfort, greater safety. We confidently look for this to continue until the railway of the next thirty years shall bear the same relation to that of to-day as ours does to that of our fathers. In the

same way, what may be called the "Science of Railroading" has developed and improved, and is developing and improving day by day and year by year.

Thirty years ago rule-of-thumb methods prevailed. Each manager was a law unto himself, and his road was managed pretty much as he saw fit. The times developed strong men, and they made their mark upon the roads with which they were connected. But oftentimes their marks were strange, and their rule, though strong, was far from economical. Uniformity of practice was quite unknown. No two roads had the same rules. The commonest signals were interpreted differently on connecting roads, and often on different divisions of the same road.

This has been almost entirely changed. The American Railway Association, which comprises in its membership the great majority of the railways of the country, has for years devoted its labor and influence to this cause. It is owing to its efforts that we to-day have uniform time over all portions of the country. The accomplishment of this object was a task that took years of labor, and was ultimately successful in spite of most discouraging opposition. Next was brought about a system of uniform train rules and signals, and rules for telegraphic train orders. At present the Association, through its committees and by discussion at its semi-annual meetings, has under consideration methods of block signaling and rules governing the same; safety appliances; and the question of uniform rules and regulations governing employees. Owing to the influence of this Association very great improvements have been brought about all over the country in uniformity and simplicity of management, with resulting increased safety and economy.

In one respect, however, the science of railroading to-day has distinctly retrograded as compared with a period of ten or fifteen years ago,—namely, in the use of freight-car equipment. There are probably not far short of twelve hundred thousand freight-cars in existence in this country. It is safe to assert that there are at least twenty per cent. more than the business of the country requires, or than would be sufficient to move all existing traffic. Moreover, this equipment is so badly handled that each car, on an average, is in motion only one hour in each twenty-four, and the average daily mileage made by each car is no greater, perhaps less, than ten or fifteen years ago. It is true, the last ten years have seen the very general establishment of car-service bureaus all over the United States. By means of these agencies, and through their influence, the old evil of using freight-cars as storehouses has very greatly disappeared. But, while the consignees and the public generally have learned that freight must be removed promptly

and that cars must not be held indefinitely, the railroad companies have not been equally prompt in moving the cars thus emptied and released; foreign cars especially are not promptly moved; and, as a consequence, the general movement is sluggish. To look for the causes of this state of affairs and endeavor to point out the remedy would involve a discussion too technical in terms and foreign to the scope of this paper. Suffice it that the subject is of such grave importance that it has been recently a topic of discussion at a largely-attended meeting of high railway officials, and by them referred to the American Railway Association with a request that that body give it careful consideration, and, if possible, report a plan that will afford relief. That this will be accomplished the writer has no doubt, and, when done, it will be by no means among the least of the many improvements characterizing the railway of the future.

Among its most important developments will be the improved relations between the employees and the companies. In spite of numerous strikes, and much ill-feeling on both sides, there is to-day a much better feeling between the men and the corporations than existed thirty years ago. The old arbitrary methods and domineering rule have in most cases disappeared. Injustice and favoritism, once only too common, are to-day but seldom seen. Still much remains to be accomplished. The rapid increase of the trades-union idea among different classes of railway employees has been a marked feature of the past ten years. Encouraged by the success of the Brotherhood of Locomotive Engineers, the other classes of employees have organized like unions. The engineers have achieved their present position through much suffering and the hard lessons of defeat. The other unions are going through a like process. Influenced often by hot-headed and rash leaders, with but little or no consideration they have made unreasonable demands, and precipitated strikes that have resulted disastrously,—to them most of all. The great strike of last summer was the most unreasoning and most disastrous. But the end is not yet. Very many of the men and some of the leaders have been made to believe that wages can be regulated by legislation, and that laws can be devised that will bind the corporations, but leave the men free to come or go at their pleasure. These and similar fallacies must be thrashed out by actual test before the unions will be convinced. That the great majority of unions existing to-day among railway employees will change their methods and aims within the next thirty years the writer does not doubt. This will not be brought about without struggles and trials of strength. In time these unions will learn their proper place in society, and will be respected accordingly. They will learn to use their strength not tyrannically, but moderately, for the

real benefit of their members. Their agreements will be of value because they will be adhered to. Strong in their own rights, they will recognize the rights of others, and not attempt to extend their control beyond natural limits, deprive non-union men of the privilege of working as *they* see fit, or the officers of the companies of the proper exercise of *their* powers.

When this time comes, the unions should be encouraged by the companies, and the employees advised to join them. Meanwhile and thereafter the true rule that should govern in all dealings between the officers and the men is "do as you would be done by." "Be absolutely just and impartial, enforce strict discipline, and meet all complaints with patience and good temper." By such a course we will remove much present friction and hasten all the more the completion of our Railway of the Future.

THE SELECTION OF MOTIVE POWER.

(SECOND PAPER.)

By Charles E. Emery, Ph.D.

ANOTHER type of moderate-speed engine has been developed, in which the details of high-speed engines are used, thereby securing a somewhat simpler engine, some forms of which are also economical.

The accompanying table shows approximately the cost of steam-power under conditions differing as to the amount of power required and the type of engine employed. The calculations are based upon the average results obtained in practice rather than those shown under merely experimental conditions. The cost of coal at three dollars per ton is derived from conservative but fair values of the water per indicated horse-power per hour as well as the evaporation per pound of coal for the several engines and powers stated in columns 2 and 3. On such basis the coal per indicated horse-power per hour varies from 5.6 pounds for the small simple engine to 1.65 pounds for the triple compound engine, whereas experimentally an indicated horse-power should, with an engine of the kind last named, be obtained for less than 1⅓ pounds of coal. The conservative quantities mentioned are increased to allow for ten per cent. friction between the horse-power in the cylinders and that delivered at high speed to a jack-shaft or equivalent; and, in addition, ten per cent. is allowed for the various wastes incident to starting and stopping fires, so that the hourly cost of coal in column 4 is higher than would be determined by a mere theoretical discussion, though believed to be fairly correct for the conditions of average practice. The costs given for labor, supplies, and repairs in columns 5 and 6 have been derived from such costs under actual practical conditions. In columns 7 and 8 it is assumed that the cost, under average conditions, for taxes, insurance, and a contribution to a sinking-fund to provide for renewals, is five per cent. of the estimated total cost of the machinery in place, including foundations, buildings, and chimney; in addition to which in column 7 five per cent. is added for interest on first cost, or dividends on stock representing the same, and in column 8 an alternative charge of ten per cent. for the same purpose. The latter is believed not to be too high for the ordinary work of stock companies, as the company would in general endeavor to raise the actual cost on bonds upon which interest must be paid, and expect to pay, in addition, a dividend on stock of a like amount. Columns 10 and 11

show the total cost in cents per net horse-power per hour, the former being on the basis of five per cent. interest, and the latter on the basis of ten per cent. Columns 12 and 13 show these quantities so extended as to exhibit the corresponding costs per horse-power per year. A study of the table shows clearly that the cost of the power decreases rapidly as the power increases, independent of the cost of coal, which is decreased by the use of more economical engines. The cost of labor largely influences the result first stated, although for the smaller engine only part of the services of one man has been charged. For the larger engine the interest has a much larger influence than is generally considered. Considerably lower costs are frequently given, for the reason that a less conservative and practical basis is employed to ascertain the cost of the coal; and, moreover, many of the items of cost herein stated are frequently omitted entirely, though all have an important influence on the final result. For more elaborate investigations on this subject more extended tables prepared by the writer may be consulted.* It should be borne in mind, however, that all tables are necessarily based on assumed conditions, and therefore only show approximately the results to be expected in a particular case.

It is possible to locate some branches of manufacture where means for supplying power have been already established. This may be water-power direct, or it may be water-power transmitted to a city electrically, as proposed in connection with Niagara Falls, or a steam supply from a street system, or even a supply of power by belt in a building. For each of these cases the above table on the cost of steam-power gives a fair idea of what the manufacturer can afford to pay. If the location for the manufactory to be operated by water-power is between two canals of different elevations, and the manufacturer must put in his own canals, wheel-pits, and races, the cost of these should be considered in connection with the rental. If electricity is furnished, but not a motor, this cost and the consequent connections must be considered. These illustrations are sufficient to show the principle, but the question of reliability of supply, the certainty of doing work every day and hour in the year that it is required, must be considered in connection with the various other questions, such as adaptability of location, contiguity to markets, and rates of transportation.

The value of a water-power depends in general upon the reliability of the supply. A torrential stream running only at times during the fall, winter, and early spring is, however, available for power purposes under certain conditions, if the cost of the plant can be kept down so that the question of interest is not of a serious character. Along such a

*See Trans. of the Am. Soc. C. E., Vol. XII., November, 1883. See also Trans. Am. Inst. El. Eng'rs., Vol. IX., March, 1893.

COST OF STEAM-POWER.

1	2	3	4	5	6	7	8	9	10	11	12	13
			Cost per Net Horse-Power.									
	Kind of Engine	Net Horse Power.	Per Hour for Coal at $3.00 per ton.*	Per Hour for Labor.	Per Hour for Supplies and Repairs.	Per Hour for Sinking Fund, Taxes and Insurance; 5% of total cost added to.		Per Hour for Coal, Labor, and Supplies.	Total per Hour.		Total per Year of 3080 Hours.	
						5% Interest and Dividends.	10% Interest and Dividends.		For 5% Interest.	For 10% Interest.	For 5% Interest.	For 10% Interest.
			Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	Dollars.	Dollars.
A	Ordinary Non-Condensing	10	.9705	1.00	.28	.1948	.2921	2.25	2.45	2.54	$75.46	$78.31
B	Automatic Cut-off Non-Condensing	75	.5556	.37	.19	.2110	.3165	1.11	1.33	1.43	40.96	44.04
C	Automatic Cut-off Condensing	150	.4239	.25	.14	.1948	.2921	.814	1.01	1.11	31.11	34.19
D	Compound Condensing	250	.3465	.17	.09	.2078	.3117	.607	.815	.919	25.18	28.40
E	Triple Compound Condensing	500	.2697	.11	.08	.2338	.3507	.460	.694	.811	21.38	25.06

* As stated in the text, the coal per hour has been calculated on a conservative basis designed to represent average practice rather than the results possible with apparatus in perfect condition. The basis is 42 pounds of feed water per H.P. per hour for line A, 28 lbs. for line B, 22 lbs. for line C, 18 lbs. for line D, and 14 lbs. for line E, and evaporations per pound of coal of $7\frac{1}{2}$ pounds for line A, 8.25 lbs for line B, and 8.5 lbs for the remaining lines. With engines of the kind stated, proportioned for the work and in good condition, the water consumption should be 2 pounds less for each engine, and an evaporation of 9 pounds of water or better per pound of coal could frequently be obtained. As the costs are generally stated for the indicated horse-power, it should be noted that a friction of 10% has been assumed to cover losses not only in the engine, but due to transmission to a jack shaft. For engines running 24 hours per day, the allowance of 10% of the fuel for starting and stopping fires should be decreased. Engines generally keep up their economy for long periods, but the amount of coal is frequently increased by carelessness in connection with the selection of the fuel, the firing, care of boilers, &c.; so, even if the engines require 2 pounds less water than assumed, the coal required generally costs fully as much as stated.

stream the farmer's boys can get in their harvests in the dry season, get out and haul logs in the winter before the snow melts, and saw them by the water power when the stream is full. In such case the labor having other occupation is never idle, and a condition of things is possible which is impracticable under regular manufacturing conditions. The same condition of things can obtain on a small stream with a large mill-pond, if the miller has a farm or work-bench to occupy his time while the mill-pond is filling up, the conditions being somewhat the same as for a windmill.

To determine the conditions under which water-power is more advantageous than steam power, it is necessary to establish a basis of comparison. From considerations above stated it will be seen that the cost of steam-power depends in part on the price of the fuel at the particular location, and in part on the cost of the maintenance and repair of the machinery required to produce the power, together with interest and dividends on the capital represented by the first cost of the plant. The cost of water-power is represented by the interest on the cost of dams, canals, races, wheels, and means of transmission, together with the cost of maintenance and repair, but in addition, for most locations, contingent allowances must be made for damages from floods and ice and loss of profits from stoppages due to lack of water, injury to plant, &c. In most factories where power is derived from water, steam is also a necessity,—at least for heat and various manufacturing purposes,—and it is well known that the best way to utilize the power for variable streams is to provide duplicate plants for water and steam, in which case the saving due to the water-power is represented chiefly by the cost of the fuel saved, and this is partly offset by the increased interest and maintenance charges due to the double plant. It will thus be seen that the mere fact that water from an elevated source is going to waste in large quantities does not necessarily mean that the power thereof can be utilized economically in comparison with power derived from a steam-engine. A solution of the problem can only be obtained for each particular case. For illustration, we present a comparison we made some time ago in relation to the cost of water-power on the Merrimack River.*

In that case the property at particular points had been developed by companies at a cost of at least $77 per horse-power, and the lessees of the power had put in head gates, flumes, wheel-pits, wheels, and tail races at a cost of $45 per horse-power of wheels, or about $65 for each horse-power utilized on the average throughout the year,—making a total cost of $142 per horse-power. "If we consider that accidents are liable to happen to the best-constructed hy-

*See supplement of article in Trans. Inst. El. Eng'rs. previously referred to.

draulic work, we should charge at least 2½% of the original cost for depreciation, say 1¼% for repairs, and about 1¼% for taxes, or about 5% independent of interest account. If, then, on the principles above developed, we charge 10% to an account for interest and dividends and allow 2% for operating expenses, the total annual charge becomes 17% of the original expenditure." Seventeen per cent. of $142 is $24.14, on which basis the cost of water-power appears to be about the same as the cost of steam-power with the most economical engine shown in the above table. The cost of coal on the Merrimack River, however, is greater than three dollars per ton; so, on the basis discussed, steam-power appears to be cheaper, and this conclusion is further emphasized by the fact that steam is required for other purposes in all the mills, and that heating, boiling, &c., can be done efficiently with exhaust-steam. The power from engines furnishing exhaust-steam is obtained at a nominal cost, as the heat in the exhaust-steam can be charged to another account and amounts to about eighty-five per cent. of that taken from the boiler. From these considerations it would appear that there would now be no object in establishing cotton mills along the Merrimack, for mills built on the seaboard would have a decided advantage in the price of coal and in the transportation of raw materials and finished products. In a general sense the comparison is correct, for steam-mills in Fall River do compete in the market with those having water-power in that place and on the Merrimack. A more recent investigation of the subject developed, however, many reasons why the water-powers on the Merrimack will never be abandoned, and some reasons even for rebuilding the same if destroyed. Although the water-power is owned by a separate company at each place, the principal stockholders are the companies owning the mills. In most cases the business of furnishing the water has been very remunerative on account of original purchases of land upon which now stand large portions of cities. Moreover, with such an organization, the surplus profits paid for water-power to the power company are really returned to the mill-owners. It follows, therefore, that, if we consider the actual results by eliminating the independent company, the mill-owners obtain their water-power under quite advantageous conditions. Practically the cost to them is simply that of maintenance. The dam, canals, and permanent struuctures were well built in the first place, and very little is required for keeping them in order. The same is true of the sub-canals, wheel-pits, and races at the several mills. The greatest item of cost is the renewal of the wheels themselves; so the cost to the mill-owners in such a location is practically this last item, plus the cost of maintenance of permanent work, together with interest on an investment which itself pays a divi-

dend and therefore pays such interest. Moreover, the rate of interest assumed is too large, if the property be considered as practically owned by one association. So also, for reasons stated, the large rate of depreciation named above should only apply to structures that wear out rapidly, like the wheels and gates. Such a modification of the items of interest and depreciation greatly reduces the cost of the power to mill-owners. To determine an exact balance for a particular location would require an accurate knowledge of facts not entirely available, and the details in any case could not be discussed in this article, which is necessarily confined in the main to general principles.

From the above considerations it will be seen that an old established water-power may be more valuable than a new one, for the reason that the stability of the permanent structures has been established by time, and a low rate of depreciation may be fixed by experience. No new company could build a large plant without providing for the various items of cost given above. If collateral profits are expected to meet the interest, they should be considered; and, if the work is well done, as it should be in every case, the rate for renewals stated above is too high for a long period of years, but for safety should be considered for a reasonable time to provide for an unexpected contingency. The safest way would be to put a definite percentage of the original cost of the plant each year in a sinking-fund, and, when the sinking fund becomes large enough to pay for renewal of structures most likely to be destroyed by accident, it should be stopped, but kept at interest as an asset. Meanwhile a very low rate of depreciation can be charged against the remainder of the plant, so that the condition of the books is always on the safe side. It will be seen, therefore, that there are some important financial questions to be considered, and that a water-power available for a long time may have a very great value, even when compared with steam-engines under modern conditions. In deciding the questions for a particular case, a special investigation must be made, taking all considerations into account. There are locations where water-power may be developed so cheaply that the principal question is to ascertain if it can be utilized. The answer, independent of the question of establishing a new city, largely depends upon the availability of proper means to transmit the power to cities and manufacturing establishments at a distance, or to points near mineral deposits, where power is desired. Wire-rope transmissions are available for distances of a few miles, though generally limited to a few thousand feet Air-transmission is desirable for mining purposes, as the air discharged from the working cylinders assists in the ventilation of the mines. There are also some large installations in which air is used to transmit power several miles. The air is com-

pressed with powerful pumps, becoming thereby heated to such an extent that it must be cooled artificially. This cooling represents a loss of energy, to which must be added the loss due to friction in the pipes and the losses due to the engine operated by the air. For these reasons the efficiency of air-transmission is generally considered to be only fifty per cent. for short distances, and is generally less as the distance and number of points of supply are increased. Compressed air is used commercially in Paris on the Popp system, and Prof. Riedler has shown that the efficiency is materially increased by the use of reheaters, which to a greater or less extent restore the heat lost in compression, and thereby make the air operate more efficiently. Of late electrical transmission has come to the front, having been made practicable by the use of alternating electric currents of high tension.

Great interest was excited in this subject by the transmission of upward of a hundred horse-power a distance of one hundred and eight miles from Lauffen to Frankfort during the Electrical Exhibition at the latter place in 1891. The transmission was obtained with an efficiency of about seventy-five per cent. from the power delivered by the water-wheel at one end to that delivered by the electric motor at the other. The resulting loss of twenty-five per cent. therefore included the losses in the generator and the motor, the line losses, and those due to step-up transformers at the transmitting end and step-down transformers at the receiving end; so the result, independent of capacity, was electrically and mechanically a great success. Further developments were checked for a time on account of the comparatively large cost of that installation, particularly in relation to the capacity actually obtained. Since then, however, the subject has been taken up by the principal electric companies here and abroad, and the cost of the work brought down to comparatively reasonable limits, so that under its early advisers the Cataract Construction Company apparently expected to be able to transmit and sell power in Buffalo for something like one-half the cost of steam-power. Later developments, and perhaps the advice of the writer and others, called attention to the many features to be considered in developing such a problem, and as a result prices have been materially increased. There is no question but what water-power may be obtained very economically under the conditions obtaining at Niagara Falls, and should be sold at very reasonable rates on the property of the Company. The question just how far it will be practicable to transmit the power electrically at a profit to the company and with advantage to the consumer must be developed on a commercial basis of bargain and sale, the same as dealings in any more tangible commodity with the delays incident to such transactions.

No such questions arise in the mining regions of the West where coal is high-priced. Quite a number of installations have been made in such localities, which are operating satisfactorily between points separated by considerable distances. Some water-powers have also been developed at the East in the vicinity of cities, one notably at Sewall's Falls on the Merrimack, near the city of Concord, N. H., where tri-phase alternating-current electric generators at the Falls furnish corresponding electric currents which are distributed in the city for lighting and power purposes. The results of all the applications, though encouraging, are not yet sufficient to warrant the early realization of the dreams of the sanguine that ere long all the cities of the country will be supplied with power, light, and heat by electrical transmission from waterfalls and coal-mines, but progress is being made rapidly, and developments as wonderful as those already achieved in the past may be reasonably expected in the future.

MUNICIPAL CLEANSING AND PUBLIC HEALTH.

By Geo. E. Waring, Jr.

IT is not yet known exactly *how* the accumulation of filth in a town favors epidemics of disease, nor is it necessary to discuss this here; for, while there are numerous examples of long-continued immunity from disease amid most filthy surroundings, there are records of a great many fatal outbreaks by which communities so situated have been suddenly devastated.

There is an almost unbroken record of the final disappearance of oft-recurring epidemics and a steady improvement of the public health following the draining and cleansing of filthy towns and the supply of good water.

It is usual to measure the health of a community by the *death-rate*. The true measure would be the *health-rate*. There may be a vast amount of sickness, and of costly disability, with a very low death-rate; but a high health-rate is an unfailing index of good sanitary conditions, and it ensures a low death-rate as a matter of course. It is probably safe always to say that, while man may so far withstand the influence of filth as not to *die* from its effect, the public *health*—the vigor, efficiency, comfort, and happiness of the people—is likely to be grievously lowered by it.

It is a fundamental principle of municipal economy that what leads to health leads to wealth. Yet there is no other self-evident proposition to which public sentiment is so indifferent. Nothing is easier than to awaken popular interest in a new city hall, a brick pavement, or a new fire-engine house, and nothing is more difficult than to raise it to the paying point in favor of good drainage, clean streets, and enforced sanitary regulations. It often requires the stimulus of a fatal epidemic—a sharp, quick, and repeated stroke of death—to loosen the public purse-strings in the interest of the public health. Sometimes even this is of little avail, and we have to await the influence of a great popular panic of dread, as of cholera or yellow fever. The cholera scare of 1892, when one enthusiastic newspaper doctor said: "The cholera germ is actually thundering at the gates of New York," did more good to the crowded tenement-house districts of that filth-ridden city in a few weeks than had been accomplished during years of indifference. The first case of yellow fever at Brunswick in 1893 frightened its people to flight, and instituted a heartless "shot-gun quarantine" throughout the whole region into which they fled. During the whole season there were fewer than sixty deaths, and most of these were believed by experts to have resulted from the perennial "malarial fever," which is

always very fatal along that coast. As a result, Brunswick is now being sewered in the most effective way, and sanitary regulations are being enforced which, with the improved drainage, will save more lives every year than have been lost through yellow fever in any ten years, to say nothing of the reduction of sickness from minor malarial diseases, which have constantly sapped the vigor of the people.

The dread of yellow fever is not unnatural, for its devastations in Boston, New London, New Haven, New York, Philadelphia, and most of the larger Southern cities have been terrific. The improvement of health conditions seems now to have driven it into the south-eastern corner of the country. Memphis was reclaimed after its very fatal epidemic of 1878–9. New Orleans was first fenced in by a quarantine, which has at least coincided with immunity from yellow fever, and it is now being sewered.

It is safe to say that there are more deaths in the United States every year from distinctly "preventable" diseases, which are always with us, than have been caused by yellow fever and cholera together in all the thirty years since the war. Yet we take these deaths as a matter of course, and we pay no official regard to the twenty cases of disabling and painful illness that each death is estimated to represent.

Let us take, as a concrete example, the case of a town that has only twelve deaths from typhoid fever in a year. This disease can be entirely extinguished. Every death from it is an unnecessary death,—as much so as a death from small-pox. The town in question therefore suffers, monthly, the private execution of one of its unoffending citizens, in expiation of a crime that may be partly its own and partly its neighbors. The people accept this execution as calmly as they would accept a monthly death from old age. They go on electing the usual city officials and voting money liberally for pavements and new fire apparatus; but they leave the care of the public health to agencies that were considered adequate at a time when we still supposed that the question of life and death was in the hands of God, and was to be determined largely by prayer. We now know that in this case, as in so many others, "laborare est orare"; but, while we may trust less to prayer than we formerly did, we are still slow in effective labor.

While great advances have been made in sanitary knowledge and practice in a few towns and among a limited class of the people, when we come to consider the 12,000,000 inhabitants of towns of more than 1,000 and not more than 25,000 population, we find that, as a rule, sanitary improvement hardly exists. With the great majority of these towns, the beginning of the sanitary impulse, beyond the occasional influence of a striking epidemic, or the fear of an impending epidemic, has hardly yet been felt.

It is to towns of this class that I propose chiefly to address my effort, as the field in which the greatest good may be accomplished, and in which the accomplishment is most needed. Messrs. Collingwood, Haupt, and Hering will enrich this series with information in regard to engineering elements of sanitary work, as applied to the large cities; and what I may have to say as to sanitary regulations is of universal application,—to the village and the metropolis.

The subject divides itself naturally into two sections,—Construction and Administration.

CONSTRUCTION.

The first works called for in sanitary improvement are those intended to get rid of such household and factory wastes as may properly be carried away by water flowing through confined channels. This is the part of sanitary drainage that is called sewerage. It is not necessarily the sewerage practised in the larger cities, where it is, or is supposed to be, a requirement that clean rain-water, as well as foul drain-water, should flow off together in large conduits. It is a much cheaper, simpler, cleaner, and less odorous device. In its best form, it is an outgrowth of, but an advance upon, the "separate" system of England. It is a strictly separate system, to which, beyond the very small amount of water required for flushing, nothing is admitted except certain industrial waters, water-closet matter, sink and laundry wastes, etc.,—nothing, that is, but water which has been fouled in houses and shops, and of which it is necessary to get rid.

This system was first introduced by the writer, at Memphis (1880). It has since come into such general use in all parts of the country, for minor towns, that it bids fair soon to become the universal American system. The engineer of the improved sewerage of Boston, who successfully contested my recommendation that the "Memphis" system should be used there as a basis of improvement, and who was long the most effective partisan of the "combined" system, said, in 1891, in the discussion following Dr. Barnes's paper on sewage disposal, read before the Massachusetts Medical Society, that "it would have been better if Boston had adopted the separate system, as recommended by Colonel Waring."* The sewerage of New Orleans is being carried out on the lines which I laid down in 1880, with a complete exclusion of storm-water.

These facts are stated to give assurance to the reader that, with the possible exception of the larger cities, the question as to the "separate" system or the "combined" system has been definitely settled by sufficiently long and ample experience.

* Or words to that effect.

In the larger cities storm-water must be carried off underground from points at which it accumulates in such volume as to be seriously objectionable. These points are reached only at considerable distances from the limits of each drainage district, and the outlets from them may be so arranged as to constitute only a modest portion of the whole length of sewers.

These outlets may serve as combined sewers, carrying the outflow of the separate sewers, with which alone the upper portion of each water-shed should be supplied. In support of this opinion it may be said that Baltimore, whose sewers are still mainly the street-gutters, had, in 1880, with two hundred and ninety miles of streets, less than twelve miles of sewers. These were constructed in flooded districts, to carry off accumulations of storm-water. Statistics for 1890 are not yet available, but there has been no change in the principle on which the sewers are built, and their total length is still trifling as compared with the length of streets. It is generally thought that it is only in hilly towns that this limitation of the length of storm-water sewers can be made. This is a mistake. The flatter the inclination,—even to the rate of one to one thousand, if the gutters are at all carefully graded,—the greater the distance to which storm-water may be kept on the surface.

One other consideration should have a great influence over the choice of a system. It is that we are fast nearing the time when the purification of sewage will be made imperative in a great majority of cases. It is also necessary, in many towns, to pump the sewage to a higher outlet. Under both of these conditions rain-water should be rigidly and completely excluded. The system should be "an efficient and well-regulated machine for the speedy and unobjectionable removal of water-borne filth, and its delivery as a substantially uniform product at such a point as is desired, and in a condition capable of treatment in a uniform manner by a uniform plant, whether chemical, mechanical, or otherwise." *

The attempt to admit roof- or yard-water, and to get rid of the surplus by storm overflows, is "a delusion and a snare." It has been found in England that what is there called the separate system—which excludes *street* water—has its flow increased by storms to as much as eleven times.† As the requirement for purification or for pumping increases, the "storm overflow" device will be found to be more and more unsatisfactory.

The drainage of houses is not a public duty, but it is a public duty to require that houses be drained and that the work be properly done.

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*Charles H. Latrobe.

†W. Santo Crimp.

This is the most important part of sanitary drainage, because it is the part by which the people are most influenced. Bad conditions within the confined atmosphere of the house are much more dangerous than bad conditions in the open streets. This fact is easily overlooked, because the ill-effect of imperfect drainage is popularly supposed to be caused by "sewer" gas. Whatever this term may represent, sewer-gas is more often the product of bad plumbing in the house than of bad sewers outside of it. It is always the result of improper arrangement or of bad workmanship, and should never exist in house or town.

The details of house-drainage cannot be considered in this short paper, but they are now well understood, and properly-formulated "regulations" should be established; and they should be enforced with vigor and precision. This is a most important duty of the health authority, not only because of the direct danger to the inmates of each house, but because a badly-drained house may establish a center of infection, and so become a menace to the health of the community. Only competent mechanics should be licensed for house-drainage work, the plans and the workmanship should be subject to competent control, all details should be inspected, and all conduits should be tested—under pressure, for the peppermint test is another snare and delusion. No connection with the sewer should be permitted until the proper officer *knows* that everything is right.

Under the head of construction comes also such regulation of unoccupied areas as is necessary to secure the prompt flowing away of all storm-water that the ground cannot absorb; such regulation of gutters as shall ensure their easy cleansing; such regulation of street surfaces as shall make it possible to sweep them clean; and other details of more or less importance and practicability, according to the size and the wealth of the town.

ADMINISTRATION.

The preservation of the public health depends, after all, much less on construction than on administration. As in good house-keeping, so in good town keeping, "eternal vigilance" is the price of success. A country house in Holland may have no drain, even from its kitchen, and no water supply save the maid-servant's neck-yoke cans, filled at the canal, but the eye of the mistress is an all-seeing eye, and there is nowhere permitted so much accumulation of wastes as would feed a roach. An American town may be without drains and without water-works, and still be kept as clean and fresh as Dutch towns invariably are. No town is "self-cleansing"; the process of proper maintenance is not an automatic one. The health officer and his staff can never relax their watchfulness and their activity without an immediate falling-off in cleanliness. The production of garbage, ashes, dust,

waste-papers, rubbish, manure, and the manifold offscourings of life and industry, never stops; and their collection and removal must never stop. The only effective—the only economical—way to clean a town is to clean it constantly.

The writer has traveled much, and usually with an eye to sanitary conditions. He has never seen a clean town in the United States, and he knows of none that pretends to have a good scavenger service where a better result could not be obtained, at less cost, by doing the work more in detail and more constantly.

One of our great present difficulties is due to the custom of encumbering the public service with a vast amount of work that should be done by the people themselves. Nothing should be thrown into the streets, or deposited for removal by the public scavengers, that can, even at some cost and inconvenience, be disposed of on the premises where it is produced; nor anything that can be made to pay the cost of its collection and removal,—such as paper, rags, sticks, wine-boxes, flour-barrels, straw, and bottles; nor anything that can be burned—cremated—in the house which desires to be rid of it, or which it would be worth "The Golden Dustman's" while to collect and sell from the public dump.

Above all should the people be prevented from littering the streets with scraps of paper, orange-peel, banana-skins, and other rejectamenta, which they now shed as they walk, in disregard of the fundamental principle that the easiest way to keep clean is not to make foul.

Removal from the streets by the public service should be limited to road-detritus and horse-droppings; and, from the houses, to clean ashes and such refuse as cannot be burned, sold, or given away. The collection of ashes may be so regulated that the ash-barrel shall not stand on public sidewalks; and, in short, by proper attention to details, the whole service of public scavenging may be made much less conspicuous than it now is.

The cost of such service would not be excessive, but, cost what it may, it should be performed. There is no way in which the same money can be made to bring a better return. Neither fine civic architecture nor beautifully kept parks will give such attractiveness to a town, or incite such a laudable pride among its people, as the perfect cleanliness and orderliness that a proper administration may be made to maintain. Valuable though parks and "breathing spaces" are to the public health, the perfect cleaning of streets, and such cleaning of houses as the health authority may properly enforce, will be even more valuable.

It would make no bad motto for municipal guidance to paraphrase

the Scripture injunction and make it read: "First pure, then beautiful."

The work of municipal house-cleaning outlined above ought to come under the control of the health officer, but, if it does, this officer must be a rare sort of man. There are some reasons why he should be a doctor, but they are rather theoretical than practical, and it is rare to find a doctor, qualified for work demanding so much executive ability and so much capacity for labor, whose professional success, or hope of success, does not make him unavailable for an ill-paid municipal office. A doctor who seeks an easy berth, or shelter for his declining years, is not available, for the controlling reason that he is not fit for the place. The health officer should be selected for his general qualities, without regard to his profession, and he should have the aid of the city physician. Even if a physician himself, he should be called on for no professional services, or personal duties of any sort. He will do his best work by making others do his work for him.*

The most important part of the clerical work of his office will be the keeping of vital statistics, the securing reports of cases of contagious and infectious diseases, the recording of the action taken concerning these, the registration of plumbers and drain-layers, the examination of plans proposed for house-drainage, and their approval or disapproval.

The executive work, aside from street-cleaning, scavenging, etc., will cover the control of the execution of such plans, the inspection of nuisances and the supervision of their abatement, the inspection and sanitary control of stables, yards, tenement-houses, market-stalls, etc., and the notification of possible causes of accidental injury to life or limb.

An important and very prevalent obstacle to the carrying out of projects of sanitary improvement is found in the fact that city officials are disinclined to delegate their executive powers. Neither a board of aldermen nor a sanitary committee can do the work under consideration so well as a single officer can. It is eminently a case where the one-man-power can be used to the best advantage, for there must be a fixed determinate policy, as far removed as possible from the uncertainty, compromises, and deviousness of an action that is controlled by several minds. The only committee that is tolerable for executive work is a committee that is controlled by one master mind. It would be better to free the master mind of the need for carrying the dead weight of useless colleagues, and to give it—under properly-established regulations—absolute and unquestioned control of the whole business.

* This, of course, does not apply to villages or to very small towns.

The health officer should be selected with the greatest care. His functions are of vital importance, and their faithful and wise performance touches the best interests of the whole community. There are few men who are qualified for the duty. One who is qualified should be well paid, well sustained by the mayor and council, and left, as far as possible, free to do his own work in his own way. He should be subject to one restraint, and to one only. He should know that, if he does not perform his duties properly, he will lose his position. So long as he does perform them properly, public sentiment should give him such support that there can be no question of his removal. Public sentiment should always be indulgent and patient with him, for he will be in almost daily conflict with individual citizens of all classes, who have to feel the pressure of his requirements, and his tact will be severely tested.

THE RELATION OF RAILWAYS TO MUNICIPALITIES.

By Dwight Arven Jones.

THE vitality and growth of every city of the present day are inseparably connected with its opportunity of becoming a part of the business and activity which are taking possession of the world. And the most casual investigator will see that with the building of railways in the United States has come a marvelous growth of vigorous municipalities, and that without means of quickly reaching distant points of this continent it would have been impossible to have reached our present development. This, moreover, has been appreciated by the people, as we have progressed. For the national government, in the aid extended to the Pacific railroads, showed its keen appreciation of the importance of opening the country through which the roads passed, and hundreds of municipalities throughout the West, by the issue of bonds, have materially aided in the construction of roads through their particular localities. It was in the early days of the country, however, that this anxiety for new roads was felt, and for many years valuable and often exclusive privileges were conferred upon railroads without a thought of the obligations of the roads themselves. But with the growth of the country, and when the vast power of the railroad systems was appreciated, there came a reactionary movement of much force, and one which has not yet subsided. Municipalities formerly the most ardent suitors have joined in the attack, and now cast avaricious eyes at the treasury of every prosperous road. But has not the time come when it may be asked whether investors have not suffered sufficiently? Whether there should not be a cessation of attacks upon railroads from all conceivable quarters? And whether municipalities in particular—the outgrowth of railroads, and their favorites in respect to rates*—should not be willing to show a just consideration for the rights of the roads? These questions are pressing for answers, and it seems a suitable time to consider some of the reciprocal obligations of railways and municipalities.

And first I shall consider the subject with respect to steam railways. It must be appreciated at the outset that a municipality occupies a dual capacity. On the one hand, it is a branch of the general government, standing as the representative of the State for a particular

* See article on "American Railways and American Cities," by Henry J. Fletcher, *Atlantic Monthly*, June, 1894.

locality, and, although it does not usurp the power of the State, it nevertheless in many respects is clothed with supreme governmental authority. But, on the other hand, the city also exists as a distinct corporate person. It has its own treasury, its own property wholly distinct from State property, and it possesses a continued personality and history which distinguish it from the State and from all other municipalities. It represents, therefore, both the interests of the State and those of its own particular locality.

But it is no part of the duty of municipalities to control railway or any other corporations. The extent of the legislative control of railways does not come within the scope of this paper, but it is well known that this control, as now exercised, has created many complex problems in railroad development, and has put great burdens upon many roads. The one power of regulating rates for service is of paramount importance—and this is a power which the courts have clearly established as a State function. If we add to this the "police power" and the right of taxation which all States possess, it is seen that railroad corporations are more likely to be crushed than to control the country.

Municipalities, however, are not charged with the responsibilities of exercising these powers. They must guard the lives and property of their citizens, and should endeavor to further their own prosperity. But they should never be willing to usurp the prerogatives of the State, or to destroy railway property for municipal benefit, or to impose unfair burdens upon railway corporations. For the progress of every municipality is largely dependent upon the character of its railway service. And the public demands not only a good service, but one that shall continually improve and keep pace with developments in railroad operation. To accomplish this requires large and continuous expenditures by the railways,—facts which a municipality desiring to receive full benefits from its railway connections should not forget. Municipalities should therefore, above everything, avoid a policy of plunder, and should protest against legislation which makes them parties to it. Unfortunately they do not always do this. Thus, for instance, a recent law of the State of Connecticut, aimed at the abolition of grade-crossings and which was contested to the United States supreme court, has made it imperative upon railway corporations in that State to abolish, at their own expense, at least one grade-crossing in each year for each sixty miles of road. Under this law a railway corporation has been forced to alter the location of its tracks in the town of Bristol, to sink them below grade, to give up its old right of way, to acquire new land by condemnation, and to submit to great expenditures for damaging property and for

making all these changes, which, as it claimed, it could not afford.* And for what? So that the public of the town of Bristol might be safe in the enjoyment of their rights! No doubt a laudable object, but why should not the town contribute to its attainment? It is not just for a municipality to ask or to allow a railway to bear such extraordinary expenses without assistance from the public treasury when it has been acting within the law and the need of change has come about through no fault of its own, and particularly when all of these improvements are largely for the benefit of the town. The desirability of changes in railroad operations which make life more secure in cities cannot be questioned; but it is contrary to the spirit of fairness which should exist between the municipality and the railway which has created it to destroy a large portion of the existing property of the railway, and to impose upon it much additional expense without municipal participation. And legislation of this character is a menace to the security of private property.

Many of the exactions, however, which municipalities, by virtue of the police power, put upon steam railways passing through their limits are necessary and useful, and no serious objections can be made to them,—as, for instance, regulations concerning the speed of trains under proper safeguards and the stationing of flagmen and placing of gates at dangerous points. These matters should be controlled by municipal ordinance, and little should be left to the good intentions of the railway. So, demonstrated improvements and safeguards which will protect the public in their use of city highways should be insisted upon; but in all changes the property rights of the railways should be protected, and the municipality should give heed to the facts that its prosperity and the prosperity of its railways are vitally connected, and that the duty of protecting the interests of the people at large rests upon the State.

If we turn now to an examination of the important questions affecting the relationship of street railways to municipalities, we shall see that the same common interest, the same inter-dependence of one upon the other, exists here also, but that there is a new element brought into the problem by the fact that municipalities surrender to these corporations certain local privileges in streets, which often are of great value.

It is to the State, however, that these corporations must look for corporate life. And as the power to create corporations is one of the most valuable assets of the State, in New York, Pennsylvania, Ohio, Mis-

* See the decision of the United States supreme court, February 5, 1894, in the case of New York and New England R. Co. v. Town of Bristol, reported in Vol. 49 of the Albany Law Journal, p. 171 (Mch. 10, 1894), and see 62 Conn. Reports 527.

souri, and other States, a substantial fee must be paid for the privilege of corporate organization. Railway corporations are no exception to this species of taxation, and, although no other serious obstacles are placed in the way of incorporation, and general acts exist in nearly every State, the charter is not given until the fee referred to is paid. The State not only reserves the right to create railway corporations, but it also ordinarily retains the privilege of altering or repealing their charters, and it possesses continuing power to regulate and tax them. Formerly the State also possessed the right of granting privileges to operate railways in particular streets of municipalities, but now it is quite generally the rule to require municipal consent to any such grants, and in many instances the matter is put, by charter rights, wholly in the power of the municipality affected.

When, therefore, a corporation has been formed to operate a street railway, and its right to exist has been secured from the State at considerable expense, it must come to the city for its franchise. And there it frequently finds that franchises are no longer given away to the first applicant who can secure the necessary influence; that with the introduction of cable, trolley, and elevated railways the whole business of carrying passengers in and to city streets has been revolutionized, and is now assuming large proportions; and that these facts have not been lost upon the public. Consequently, if such a corporation comes to New York city, it finds that it must purchase its franchise at auction, and must pay three per cent. of its gross earnings to the city annually for five years and five per cent. annually thereafter.* In Chicago and Philadelphia it finds that it must pay fifty dollars annually for each surface car, and in St. Louis twenty-five dollars annually for each car, while in Baltimore it must pay nine per cent. of its gross earnings and a license fee of five dollars a car. In many other cities it will find similar charges imposed.†

When it is considered that the public streets are most valuable possessions of a city in its municipal capacity; that the necessary expenses of maintaining the city government, including its judicial, fire, police, and other departments, are necessarily great; and that the opportunities of developing the public parks and the public charities are exceedingly varied,—it seems needlessly foolish to give away these local franchises, even with the idea of thereby securing cheaper transportation for the public. For the control of rates of fare cannot safely be put in the hands of city authorities. It must be vested in

* Laws of New York, 1890, Chapter 565, Secs. 93, 95.

† See the "Law of Incorporated Companies operating under Municipal Franchises," by A. R. Foote and E. E. Everett. Robert Clarke & Co., Cincinnati, publishers (1892), under subdivision "Charges for Franchises" in the different States. And see *Railway and Corporation Law Journal*, Vol. 1, p. 121.

some independent State board. And it is a most delicate matter to tamper with rates frequently, and so kill the interest of private capital in the development of street-railway transportation. Moreover, the interest of the public in the streets of a city should be recognized, and, when valuable privileges are transferred to a corporation, the city, as a city, should receive compensation. Experience teaches that it can do so without materially lessening the value of the grant. To exact, therefore, an annual tax or license fee from these corporations does not seem unfair to the corporation, so long as the amount of the tax is not excessive: or unfair to the general public, so long as rates are low and the money received is appropriated to municipal purposes.

Where such a franchise tax is imposed by a municipality, however, it should not be allowed to tax in any other manner the capital of the same corporation, as this is double taxation. An instance of taxation of this character is found in the city of New York, where railway and other corporations are taxed under a primitive law of 1857, which has no place in the present system of State control and State taxation of these corporations. The plan of requiring payments for franchises has steadily gained favor in this country, and it is not likely that there will be any backward step; nor is it desirable for the public good that there should be, as with the growth of our cities these franchises become more valuable, and the dangers of bribery and favoritism in granting them constantly increase.

In considering the amount to be exacted for franchises, however, municipalities should not lose sight of the fact that it is highly injurious to the public to deprive the railways of the pecuniary rewards which flow from a liberal policy toward the public. More than this, it is only in the larger cities that franchises have a salable value. In villages, towns, and small cities railways are often the chief means of promoting the public welfare; hence the disposition of public-spirited citizens and property-owners to offer free rights of way, stock subscriptions, and other considerations to induce railway building. Municipalities should also take into account the fact that they cannot always confer complete privileges in the streets, because of the interests of citizens in streets which adjoin their property. Where a municipality owns its streets, the privileges it may grant are greater than when the title of property-owners extends to the middle of the street. But in either case it is now the general rule that a steam railway cannot be established in a street without the consent of adjoining property-owners; although a horse, cable, or electric railway, in the absence of statutes, ordinarily can be authorized without the consent of citizens, as these are deemed to be legitimate and incidental uses of the street as a street. Statutes, however, may prohibit the establish-

ment of ordinary street roads without the consent of the owners of abutting property, or they may, as is the case in New York, refer the matter to commissioners when it is impossible to get the consent of the property-owner. But, with respect to roads which are not incidents of streets, the railway must either obtain the consent of abutting owners or make compensation for the injuries which it imposes upon the adjoining property. And this rule is of the utmost importance in dealing with the relationship of elevated or underground railways to municipalities, because it furnishes a new reason in the added cost of the road why municipalities should not impose extravagant taxation upon them for their franchises.

In view of these considerations, and when it is remembered that the annual taxation of railways in some localities is very heavy, and that in different places it is governed by diverse rules, it will be seen that the value of a franchise to operate a street railway depends upon many local conditions; that the terms exacted in one place can be but a very rough guide for those to be exacted elsewhere; and that, in all places where a franchise has special value, the effort should be to impose a reasonable and fair charge in view of the local conditions.

In granting these rights to use particular streets, either with or without a money consideration, municipalities should exercise care to protect the interests of their citizens. Ordinances conferring franchises usually contain many important provisions, sometimes regarding the duration of the franchise, and generally in reference to the operation of the road and the duty of keeping the streets in a safe condition. In matters which concern the safety and welfare of the public, the municipality stands as the guardian of the people, and it should maintain a rigid control. But where the effort is to participate in the earnings of the road,—by limiting the duration of franchises or by insisting upon a share of the gross receipts,—cities should act with extreme caution. If this caution is not exercised, the danger is that we shall be irresistibly forced toward municipal ownership, — a result greatly to be deplored. To the present time, however, this question of municipal ownership of street railways has assumed comparatively little importance in this country, although it probably will be more and more forced upon public attention if attacks upon railway property do not subside. For, as private capital shrinks from undertaking the risks of great enterprises,—such, for example, as the establishment of a rapid-transit system for the city of New York,—the work is forced upon the public. No city can stand in the way of its own development, and it has always been accepted that, when necessary, cities should own their own water-works, supply gas, construct sewers, and, in short, undertake any public work necessary for the development of

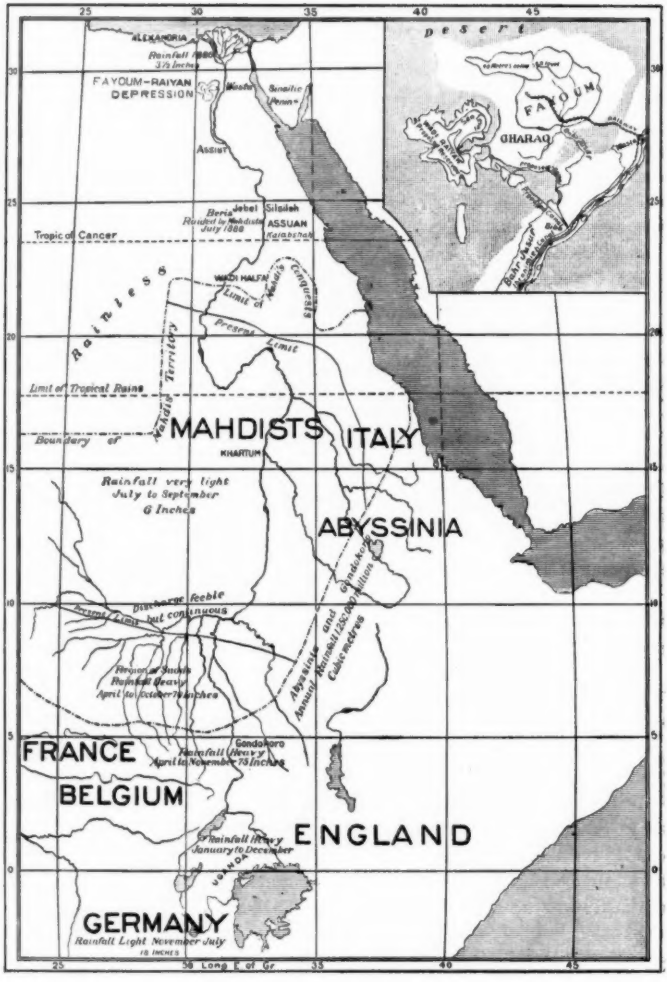
the individual community. But, although the ownership of railways by municipalities frequently exists in Europe,* in this country there is little disposition to make this a governmental function. There is, in fact, a strong undercurrent of conviction that our government was never intended to carry on business for the people. Indeed, in some parts of the country municipal ownership of street railways would not be lawful. Whether it is so or not will depend in each State upon the local constitution and statutes. In New York the constitution fixes the debt limit of municipalities, but does not otherwise prevent the use of a city's funds for its own welfare under legislative authority. The cities of New York and Brooklyn have united, under legislative power, to construct and operate a railway across the Brooklyn Bridge, and by a recent popular vote the city of New York has been authorized to undertake an elaborate system of rapid-transit for the city. But it is necessity alone which justifies this step, private corporations having failed to undertake the enterprise. In general the aim of the people should be to keep for themselves all forms of industrial pursuits. Surrendering them to be managed by the party in power, or by bi-partisan commissions, will benefit no one, and will inaugurate a policy that will not be long tolerated by the people. It is, therefore, desirable to endeavor to check every tendency toward municipal ownership; and, as means to this end, and to establish at the same time a closer relationship between railways and municipalities, the following suggestions are made:

First: Municipalities should impose reasonable charges only for the use of city streets, and should tax the property, but not the capital of street-railway corporations.

Second: The influence of municipalities should be exercised to prevent extreme State interference with street railways, so that investors in this species of property may receive a fair profit upon their undertakings, and the public may become sharers in this prosperity by having a constantly improving service.

Third: There should be an intelligent State control both of the organization of new railways of all kinds and of the operation of those already in existence, through boards of railroad commissioners, who shall receive full reports from railways and shall have ample authority to investigate facts, who shall respect alike the rights of the railway and the municipality, who shall decide disputed questions with moderation and justice, and who shall always remember that both railways and municipalities, to justify their existence, must serve the public interests.

*See article on "Public Ownership of Urban Transit," by Sylvester Baxter, *Cosmopolitan*, Nov., 1894, p. 54.

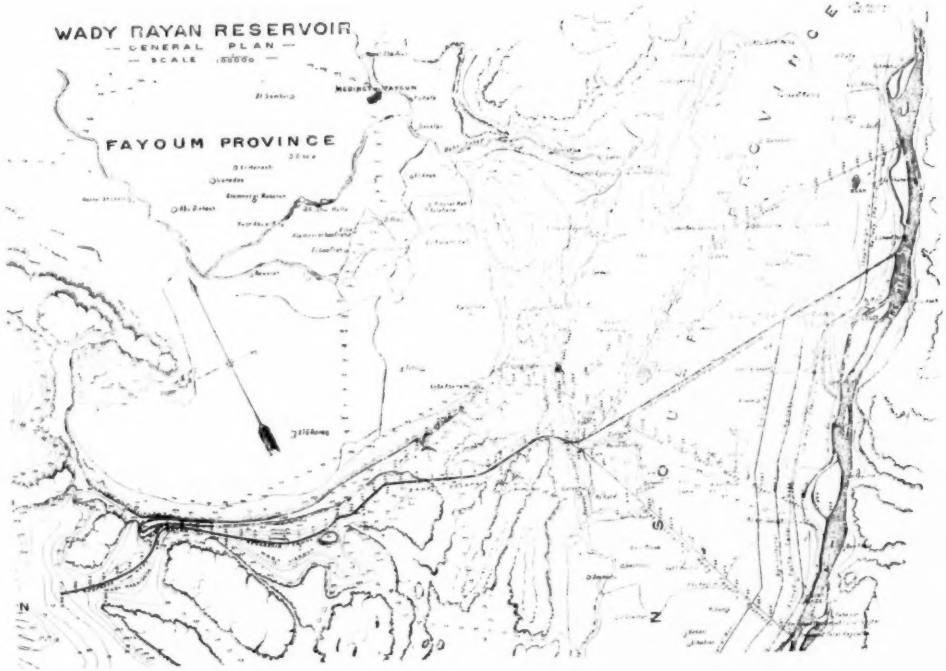


HYDROGRAPHIC MAP OF THE NILE.

ANCIENT AND MODERN IRRIGATION IN EGYPT.

By Cope Whitehouse.

THE irrigation of Egypt has recently assumed a special importance. The attention directed to the great value of land where solar heat never fails and water can be applied as required has induced inquiry into ancient systems. The engineers of the Tigris-Euphrates achieved practical results of magnificent and long-lasting character. Their works, however, have utterly perished. There was a dam of great size in Southern Arabia, of which substantial remains still exist. It failed two thousand years ago, after centuries had attested the wisdom of its builders. The Nile, on the other hand, has never ceased to be controlled by engineers, often of alien race, from the Hebrew Premier to whom tradition assigns not only the founding of the temporal fortunes of the Jews, but the construction of a canal, still bearing his name, with a record of uninterrupted usefulness lasting nearly four thousand years. From the time of Saladin, the chivalrous opponent of Cœur-de-Lion, to Mehemet Ali, little was done to change the irrigation system described by Greek travellers. The downfall of the Roman Empire suspended engineering operations on a large scale throughout the Mediterranean basin. Cathedrals rose, but aqueducts fell. The water-supply of medieval Rome still passed through ancient channels. The Pont du Gard, however, spanned with triple row of arches the ravine near Avignon, but it was not until this century that its conduit was again utilized after more than a thousand years of abandonment. A few years ago an inscription was discovered in the aqueduct below Jerusalem, which showed that the engineers of the seventh century B. C. had been able to calculate the point at which two headings driven in opposite directions would meet. While, therefore, the use of steam, and the immense advance in recent years in the construction of pumping machinery, make it certain that the twentieth century will not repeat the irrigation systems of the distant ages in which the Delta was first redeemed from marsh and desert, it is of practical importance to inquire into the ancient irrigation of Egypt, the remains which still exist, the modern improvements, and the lessons which these works teach to engineers in all parts of the world. Every engineer concerned in the training of a river, or the irrigation of a tract with insufficient rain-fall, knows that he cannot expect to find an exactly similar case elsewhere. This is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CANAL OF JOSEPH IN THE FAYOUM.

one reason, doubtless, why the literature of irrigation is so scanty. In Egypt, although the monuments are covered with myriads of descriptive pictures, and thousands of conveyances have been found relating to the transfer of land, by deed, lease, or will, no work on irrigation has reached us. Three Greek travellers express unbounded admiration for the results, but give no details as to the method. In the words of Strabo, the attention and care bestowed upon the Nile was so great as to cause industry to triumph over nature. "The Egyptian soil, when inundated by the natural rise of the river, is very fertile, but it is by irrigation that it produces the most abundant yield. Industry has completely succeeded in rectifying the deficiency and irregularity of the natural supply; so that, in seasons when the rise of the river has been less than usual, as large a portion of the country is covered with water, by means of canals and embankments, as in seasons when the rise of the river has been greater."

The latest irrigation reports of the Anglo-Indian engineers show that even in Upper Egypt this is not now attained. The valley of the Nile from Assouan to Cairo resembles those rivers of the United States in which a level bottom-land borders a river-bed, and steep hills rise on either side. As the inundation is never more than a few feet higher than the long, narrow plain, the canals and embankments

THE BAHR JUSUF, OR CANAL OF JOSEPH.

At Behnesa, fifty miles south of El Lahun, the entrance into the Fayoum.
Length, 190 miles; Flood Discharge, 2,863 cubic feet per second; Minimum Discharge, in June, 409 feet per second.
This water-course, partly natural and partly artificial, has been utilized continuously since B. C. 1600 to supply the Fayoum. The excess and drainage is evaporated at the rate of 98 inches per year in the Birket el Qerun; with a surface of 78 square miles, 133 feet below sea-level.

mentioned were required in order to secure for every acre a supply of water, and—what is of equal importance—in order that the silt-charged inundation should remain as a tranquil pool for not less than ten days It then becomes equally desirable that the waters should be run off at the earliest possible moment. No extension of area beyond the foot-hills is possible. No desert is ever irrigated, except those alluvial deposits covered with a few inches of wind-blown sand to which the term desert is sometimes loosely applied. The embankments seen by Strabo and built, perhaps, by Sesostris are still in use. The levee and the railway form a continuous line on the west bank. Cross embankments separate the plain into vast compartments, technically termed basins. The canals are needed to gain head. A basin is not usually filled directly from the river, but takes its water from a point somewhat higher up than the southern bank.

The plain itself tilts to the west. Thus the corner nearest to the river and the entrance of the canal is that which is most likely to be insufficiently covered. Again, as the earlier inundation is more richly charged with silt, it is an object of anxious thought to secure the equal distribution of the alluvial deposit. Within a few years about four million dollars have been expended, under the direction of Col. Ross, in extending and arranging the network of canals, and in substituting

MEDINET EL FAYOUM.

MOSQUE BRIDGE OF KAIT BEY.

stone culverts for the discharge. The primitive method of cutting a bank has been almost wholly abandoned. About sixty miles south of Cairo a magnificent work has been erected, designed by Col. Western, with a double row of gates for the discharge of the great Koshesha Basin, into which the discharges from Upper Egypt are to a large extent passed. Thus, in September, the Nile valley to the south of Cairo consists of a series of lakes, descending like steps, by the side of a river, whose rapid current is often higher than the still ponds. It is the task of the so-called Nile corvee to prevent a breach in the cross-banks, assailed sometimes for days by waves of considerable dimensions, as well as to confine the river itself to its prescribed course. It has never been true, as Shakspeare puts it: "The higher Nilus swells, the more it promises." On the contrary, a high Nile delays sowing; for the dramatist rightly says: "As it ebbs, the seedsman upon the slime and ooze scatters his grain, and shortly comes to harvest."

In Upper Egypt, therefore, the system of cultivation is that of inundation, except on two perennially irrigated areas, supplied with water conducted from the Nile, either through a canal of the remotest antiquity, bearing the name of Joseph, and traditionally ascribed to the son of Jacob, the prime minister of Pharaoh, who reduced the independent inhabitants of the Delta to the position of tenants of the

FORDING A CANAL.

crown, in pursuance of the system of a regulated water-supply, or through the Ibrahimieh Canal, named after the celebrated son of Mehemet Ali, but due to the energy of the Khedive Ismail. The ground retains sufficient moisture for a single crop. The whole operation of filling and emptying the basins is one of great delicacy of manipulation, and requires a centralized authority with arbitrary powers. Hence, intimated Herodotus, Egypt must always have a king. These basins are the areas of verdure described by the tourist. He ignores

MILL IN EL BATS.

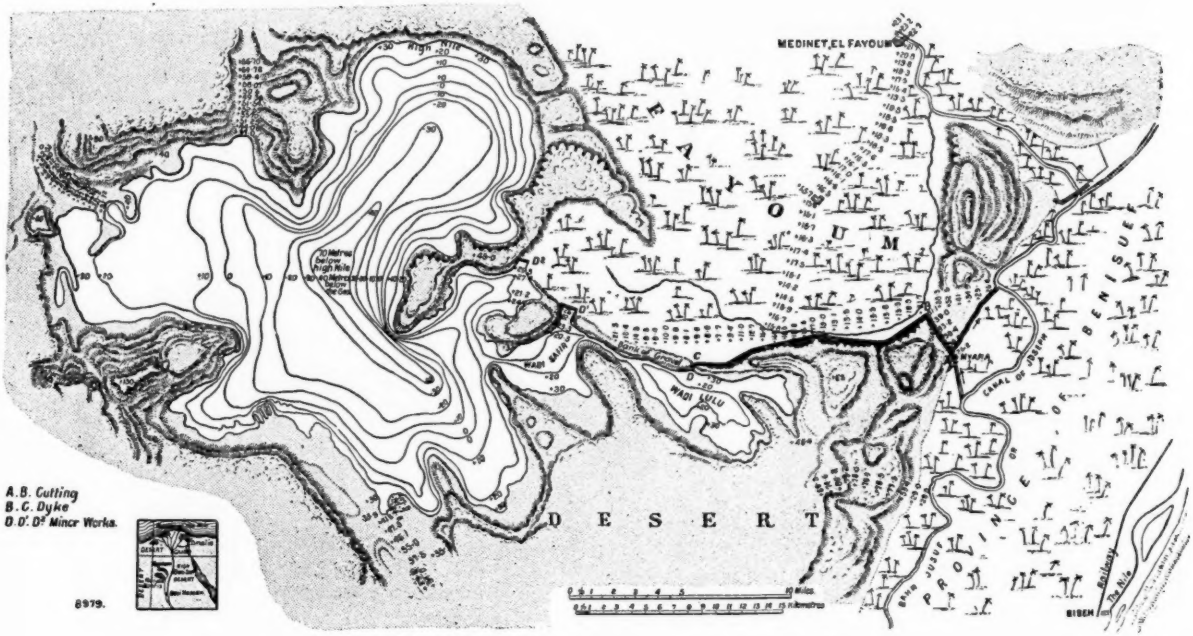
the three months during which these fields are a sea, the villages surrounded by a marsh, and the cattle dependent upon fodder. "Although Egyptian wheat costs almost nothing to raise, it is so hampered by costly transportation and excessive taxes that it is undersold in the English market by American and Indian wheats, and the owners of basin lands hardly keep soul and body together unless the basin inundation is conducted (by the government) in the best possible manner" (Col. Ross, late inspector-general of irrigation). To increase his resources the peasant adopts the picturesque method of cultivating a small area by lifting the water after the inundation crop has been reaped. "The summer irrigation of the basin is remarkable for the excessive amount of labor bestowed upon it. For eight hours' hard physical labor from March 15 to August 15, or five months, the man practically works for 50 to 60 piastres ($2.60 to $3.00). This is equivalent to wages of one-third of twopence half-penny," or less than two cents, a day.

By the side of the valley of the Nile lies the unique depression of the Fayoum. Its present cultivated area is about 300,000 acres, of which 70,000 are planted with summer crops, chiefly cotton. The inundation, with its attendant plagues, is excluded. It has been identified by me with the land of Goshen, and its fertility and strategic importance confirm the view that it was, in B. C. 1400, the best of the land, peculiarly adapted by its perennial pastures for the Hebrew allies of the Shepherd-Kings. It is the garden of Egypt, from whose vineyards, palm-groves, and fig-trees come the fruit sold in Cairo; and the Lake el-Qerun furnishes the capital with an unlimited supply of wholesome fish from its brackish waters. If cotton is grown, it is

followed by a winter crop of wheat, clover, or beans, and this is succeeded by a crop of millet. Five crops are taken off the same ground in thirty-one months. Three are sometimes harvested in fifteen months. The land-tax is $720,000; but there are heavy railway charges and other contributions to the treasury, including the corvee, or forced, unfed, and unpaid labor, and the infamous *rachat militaire*, invented and imposed as a kind of capitation tax by the British authorities. But another source of revenue remains wholly neglected.

The potentiality of wealth resulting from the conversion of a single million cubic meters per day (four hundred feet per second) falling one hundred feet, converted into electrical energy by dynamos working in a climate where frost is unknown, is obvious. It was outlined in my earliest researches, in 1882, and Gen. Stone was quick to perceive its value. The reproduction of a photograph of the great ravine of el-Bats shows that, as the plateau is below the level of the Bahr Jusuf, the water which rushes down its bed might be utilized as at Niagara. The mill driven by an undershaft wheel is one of many employed for grinding durra, a species of millet. Similarly, water-wheels, with wooden boxes or jars, alternating with paddles, used in irrigation, prove the commercial value of the wonderful gift of nature, which is not now utilized except in an infinitesimal degree. American engineers should note this, so that, if, or when, the time comes in which they are restored to the footing on which our industries stood prior to the British occupation, an opening may be found for electrical machinery, and trolley lines traverse the Fayoum and carry its produce to Cairo. The city itself will, in my

PEASANT LIFE IN FAYOUM—GOSHEN.



PLAN OF THE RAIYAN—LULU RESERVOIR ; WITH LINE OF CANAL.

Approved by Col. Western, R. E., Director-General of Works, Draughted by Mr. Cope Whitehouse, August, 1888.

opinion, be lighted by water-power. The native governor of the Fayoum, Mahmoud Bey Sabri, was last year in treaty with a European company to light the bazaars of Medinet el-Fayoum, the capital of his province, from a dynamo to be established about two miles away.

The competition of Egyptian cotton, not only in European markets, but in our own, has become a matter of most serious commercial and financial importance. It is evident that a crop sown in spring and taken off in the autumn can never be grown on inundated land. The cultivation of the Delta is, also, by irrigation, as opposed to inundation. The flood-waters of the Nile are excluded from its fields. Out of a thousand million cubic meters per day discharged from equatorial Africa in a maximum flood, through the narrow pass between the Pyramids and the Citadel, not one-tenth is utilized. The rest is conveyed to the Mediterranean chiefly by two branches of the river, defended by levees. If the ancient accounts are to be treated as trustworthy, and certain medieval maps considered authentic copies of those in use seventeen hundred years ago, the river had twelve lines of discharge, each one carried to the sea. The reclamation of the rest of the Delta would mean the addition to the productive area of 1,500,000 acres, 600,000 of which require little treatment to restore them to the condition in which they contributed to the famed luxury of Cleopatra. This exclusion of the inundation was, according to the ancient records, facilitated by the discharge of a portion of the surplus flood into the vast depressed region of the Fayoum; and, as I have maintained, also into the Raiyan Basin lying to the south. The inspector-general of irrigation, Major Brown, accepts in its entirety my view of the use of the Fayoum, as that reservoir and escape, deemed the greatest engineering work of the ancient world, and known as Lake Moeris. Whether the Raiyan Basin was used is a disputed point. The public-works ministry, however, concede that, as the map shows, it could be so utilized.

The irrigation of the Delta was begun in the early part of this century; and, in 1842, two open dams were commenced, to close the branches of the river when the Nile has fallen, and force the water into a network of canals, whose beds are higher than the bed of the river. If Napoleon proposed some sort of dam, he only contemplated an increased head for inundation. The Barrages were constructed, at a total cost of twenty million dollars. In 1863 the Rosetta Barrage was closed for the first time, but reopened almost immediately afterwards, owing to a settlement of part of the work. Commissions of inquiry repeatedly sat,—in 1863, 1865, and 1867. The most eminent European engineers were consulted by the Khedive Ismail. Their conclusions were adverse, based not merely on the extreme frailty of the structure, but on other economical grounds. In 1884,

however, it was determined to strengthen the foundations, put in new gates, and complete the canal-system to be fed from the pool thus formed. The work was executed by Col. Western with great skill. The result has been a very large increase in the cultivation of cotton, but without any considerable addition to the cultivated area. Cotton is grown instead of cereals. Sanitary and other factors have shown themselves to have been deserving of greater consideration than they received from the Anglo-Indian engineers, and the opposition of Linant and the adverse decision of Sir John Fowler are still considered by many to have been fully justified.

No further extension of cultivation in the Delta is possible without a storage reservoir; nor can the farmers of Upper Egypt be allowed to use pumping machinery, and convert the inundated basins into irrigated fields, until the deficiency thus created has been supplied from the surplus of the flood. This is the problem which, having remained dormant since the Mohammedan conquest, and barely mentioned by engineers before 1882, is now exercising the minds of the civilized world.

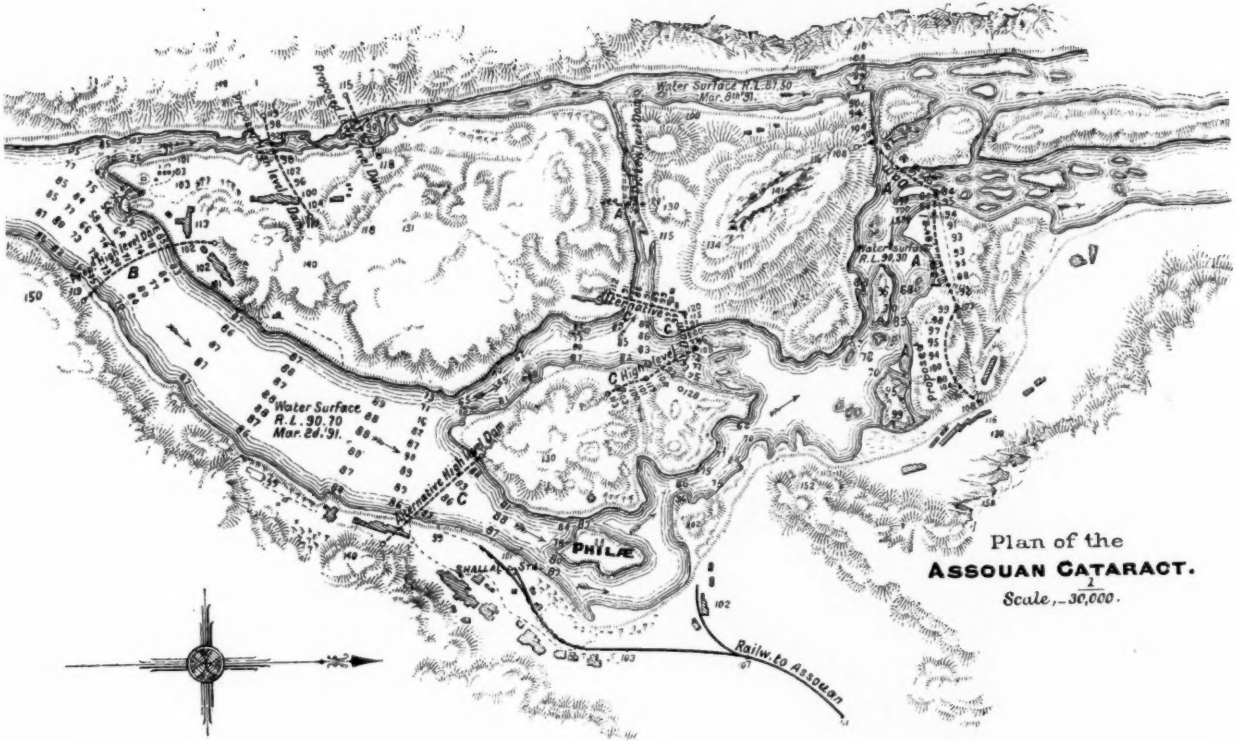
"The necessity of some vast scheme of storage for the increase of the summer supply of the Nile is universally admitted, and has been before the public in definite shape since Mr. Cope Whitehouse put forth the Wadi Raiyan project in 1885." (*Engineering*, Feb. 16, 1894.)*

The public-works ministry, on Nov. 8, 1894, obtained the sanction of the council of ministers for a projected storage reservoir in Nubia. The budget for 1895 allots the sum of £154,000 ($770,000) for the work to be executed this year. Sir B. Baker has been appointed consulting engineer to the department of reservoirs, which is continued under the direction of Mr. W. Willcocks, an Anglo-Indian engineer, on the permanent staff of the Egyptian government. The scheme proposed is an open dam with its crest at R. L. 106 meters, or 339 feet above mean sea-level. The contents of such a reservoir would be 1,064,000,000 cubic meters, or 37,590,000,000 cubic feet, or about 250,000,000,000 gallons. The water would be held up to a head of 15 meters (48 feet) and ponded back for 209 kilometers (about 130 miles). The amount of water available is less than one-third of the

* "Such authorities on Egyptian Irrigation as Sir C. Scott Moncrieff, Col. Western, Col. Ross, and Major Brown have recorded their opinion. So extensive indeed has been the literature that the name of the Wadi Raiyan ought to be as well known to the world as that of the Lake of Geneva." W. E. Garstin; Note, Public Works Ministry, Cairo, 1894.

See *Engineering*, 1885, Sep. 11; 1887, Sep. 29; 1888, Sep. 14, 21; 1890, Sep. 19; 1891, Oct. 16; 1893, Jan. 6, Feb. 3, June 16, Dec. 8; 1894, Feb. 16, Ap. 20, June 15, Aug. 3, 10. Egyptian Irrigation; W. Willcocks, pp. 301-336, 1889. The Fayoum and Lake Moeris, Major Brown, 1892. Notes, pamphlets, and maps in British Museum, London, and Astor Library, New York.

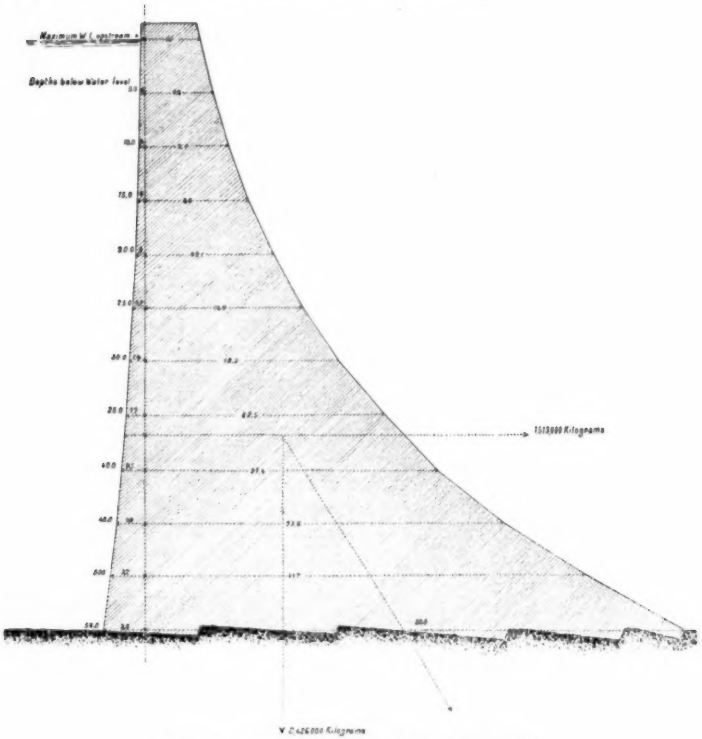
A NEW REGULATOR IN THE FAYOUM.


Water Surface R.L. 87.50 Mar. 8th '91.
Proposed Low Level Dam
Proposed High Level Dam
Alternative Low Level Dam
Water Surface R.L. 90.30
Alternative High Level Dam
Water Surface R.L. 90.70 Mar. 2d. '91.
PHILÆ
SHALLAL STR.
Railw. to Assouan

Plan of the
ASSOUAN CATARACT.
Scale, 1/30,000.

THE GREAT RAVINE OF EL BATS.

minimum required for the conversion of the valley of the Nile from flood cultivation to perennially irrigated fields, and the reclamation of the remainder of the Fayoum and the Delta. In order to extend Egypt to the limit of production attained by its former rulers, the Shepherd-Kings, the Ramesside Pharaohs, or the Ptolemies, the estimate made by the public-works ministry would require further substantial increase. Mr. Garstin, under secretary of State, gives the following figures: Upper Egypt, 1,160,000,000 cubic meters; Middle Egypt, 950,000,000 c. m.; Lower Egypt, 1,551,000,000 c. m.; or a total of 3,661,000,000 cubic meters (854,000,000,000 gallons). The expense of this dam as compared with that originally proposed, with a head of 22 meters and a capacity of 3,700,000,000 cubic meters, will not be reduced in any corresponding proportion. Even if this were the case, the immense value of an adequate supply of summer water, with its estimated annual value in increased production of $60,000,000, is sufficient to show that, should the cost of this dam not exceed $7,500,000, while a higher dam could, it was said, have been constructed for $12,500,000, the expense does not enter into the question as a determining factor. As the expropriation of the cultivated land to be drowned is only reduced by a little over one-third; as the iron-work remains the same; and as the difference is confined to the relatively



SECTION OF PROPOSED SOLID DAM. (RANKINE.)

small saving in reducing the thickness and height,—it will be seen that the adoption of this plan is a defeat suffered by the department of reservoirs. The archæologists were roused by a proposal to destroy the temple-crowned island of Philæ, and other ancient remains of historic value below the level of the proposed reservoir. They have thus far gained the day.

The structure proposed is shown in the accompanying illustrations. It may be observed that the dam rests on the surface of the rock, which is neither cut into steps, sloping the right way, nor secured by projecting masses of the rock itself. The curves are useless; and the masonry in the buttresses might more advantageously have been distributed through the dam itself.

If the Assuan dam is the best which Mr. Willcocks could design, the Raiyan plans were drafted with the avowed object of securing the

15 METRES OF WATER ON SILL OF UNDER SLUICE

In calculations for stresses with the Reservoir full, the parts of the dam to the left of XX' above EF are neglected

The openings are 2 metres wide and the piers are 3 metres wide

The calculations are made for one pier of 3 metres width & one opening of 2 metres width, or 5 metres in all

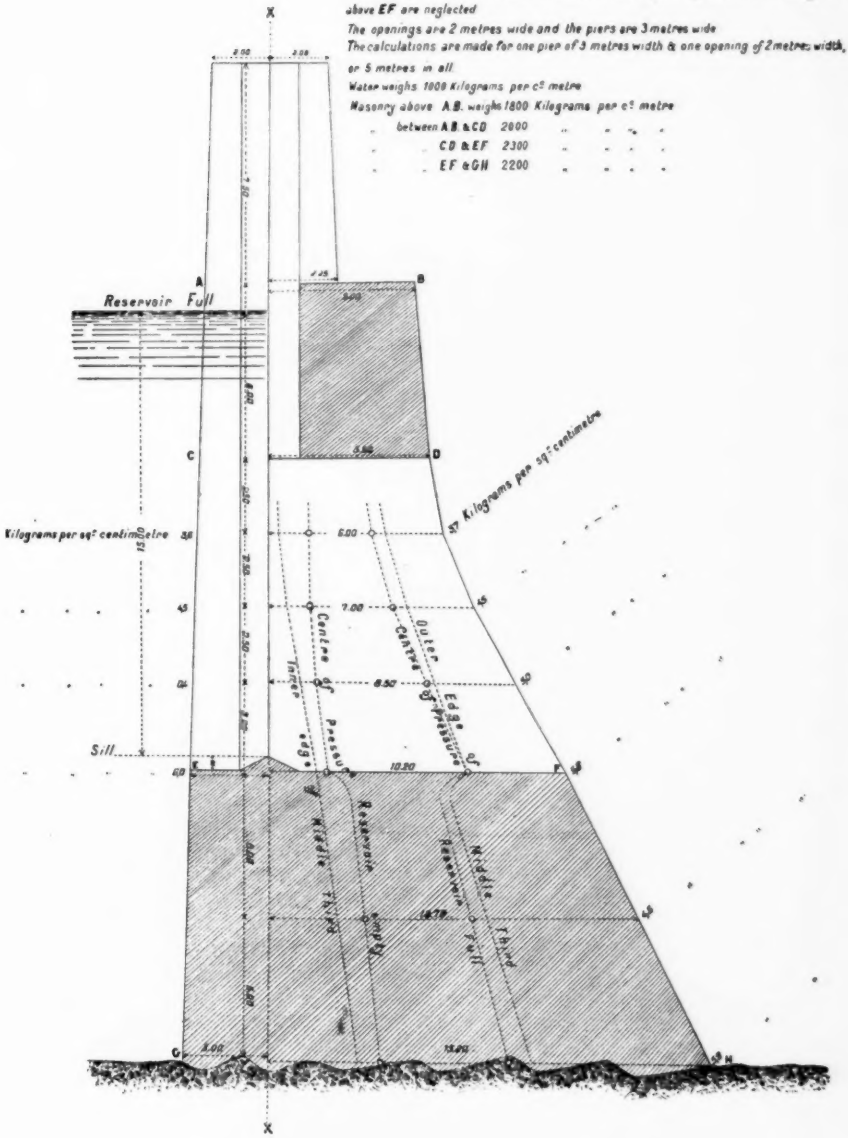
Water weighs 1000 Kilograms per c.m metre

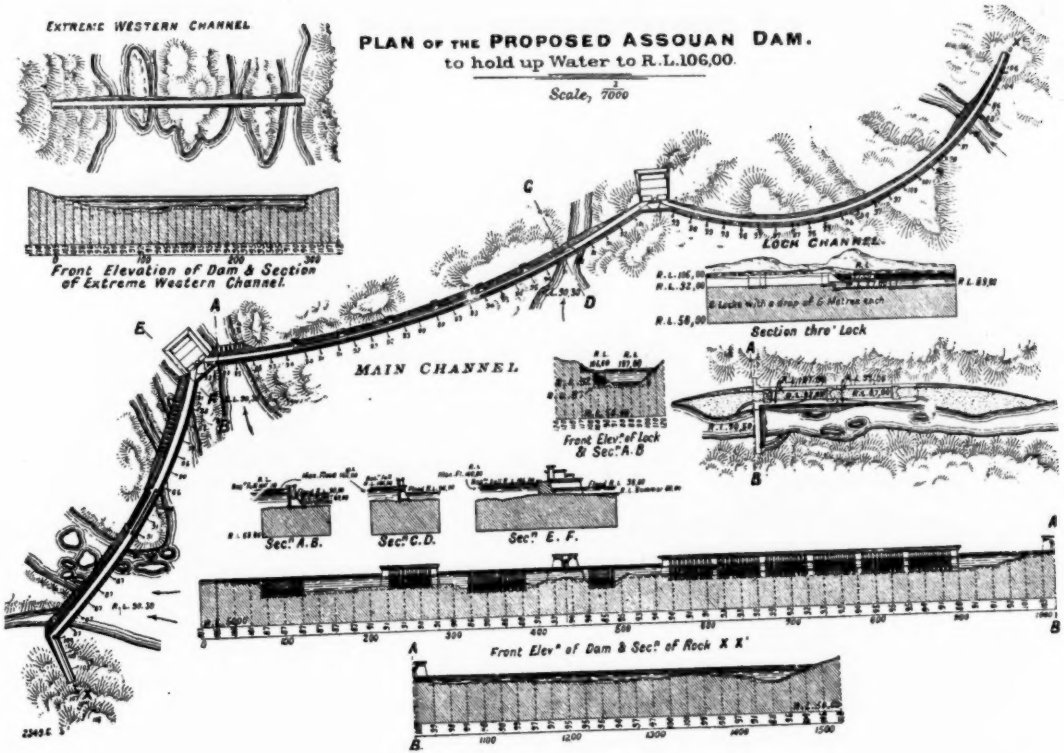
Masonry above A.B. weighs 1800 Kilograms per c.m metre

" between A.B. & C.D 2000 " " " "

" " C.D & E.F 2300 " " " "

" " E.F & G.H 2200 " " " "



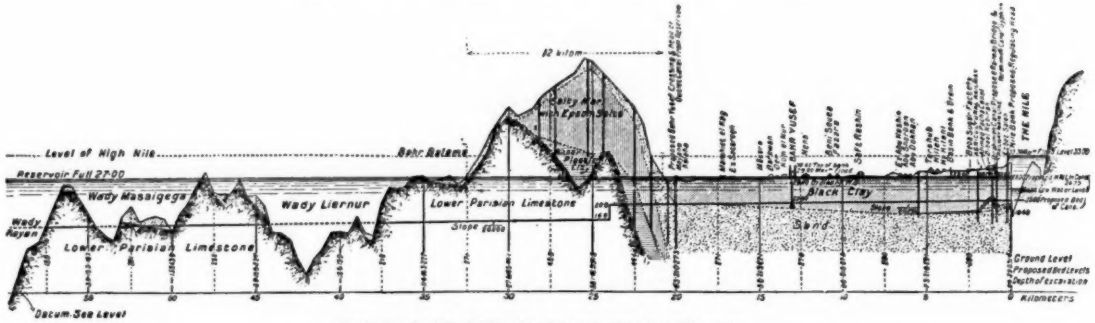

EXTREME WESTERN CHANNEL
PLAN OF THE PROPOSED ASSOUAN DAM.
to hold up Water to R.L.106,00.
Scale, 1/7000
Front Elevation of Dam & Section of Extreme Western Channel.
LOCH CHANNEL.
MAIN CHANNEL
Section thro' Lock
Front Elev.n of Lock & Sec.n A.B
Sec.n A.B.
Sec.n C.D.
Sec.n E. F.
Front Elev.n of Dam & Sec.n of Rock X X'

rejection of my scheme. The ancient system of regulating the Nile by Lake Moeris led to the Raiyan project. It was submitted to the three commissioners by the department of reservoirs in a form not approved by me. It will be noted that the inlet and outlet canal is not perpendicular to the Nile; that there is no apparent necessity for any canal at all traversing the flooded valley; that the canal has a slope to the west which is unduly prolonged; and that the design is, in other respects, open to objections which led me to refuse to accept the decision of the commissioners as final. It is fortunate for me that the errors and misrepresentations are of such a character as to dispense with any need for elaborate refutation. Lord Rosebery, Lord Cromer, and Sir C. Scott Moncrieff were aware of the intention to misrepresent the physical facts of the Raiyan isthmus; and they sanctioned the astounding perversions of the elementary laws of hydraulics. The American engineer will greet with derision an outlet canal which discharges water up a slope, with an outfall 27 feet above the intake. Apparently, in Egypt, a straight line is not the shortest distance between two points; and water, in a lake, does not find its own level, but retains a permanent angle, even when flowing in the direction opposed to that by which it entered. It will also be noted that the double lines, which represent alleged borings, were never carried down to bed-level. The profile of rock-cutting, is, therefore, the product of the imagination of the director-general of reservoirs. It was not thus in the days when Gen. Stone was chief of the bureau of surveys.

England considers Egypt as subordinated to the Anglo-Indian empire. Every effort to develop Gibraltar has met with strenuous resistance. The "Rock" is primarily a fortress, and can never —so English statesmen maintain—be allowed to become a metropolis at the gates of the Mediterranean. Similarly, if Egypt were obliterated from the map, and the Nile were reduced to the condition of the Tigris-Euphrates, it would unquestionably strengthen the present British empire. The policy is intelligible, and, if it shocks humanity, must nevertheless be considered entirely rational. It found expression in the words of a despatch addressed to me by Lord Salisbury on January 12, 1889, in which it was said that, "after full consideration, the Egyptian authorities have come to the conclusion that they cannot adopt your proposals, while the benefits which might accrue from their adoption are fully acknowledged." "I am to add," wrote Sir Julian Pauncefote, now ambassador at Washington, "that Her Majesty's agent and consul-general, while regretting that Egypt is not able to profit by the execution of the project which you have prepared with so much care and skill, states that he has satisfied himself that it has been considered with the greatest care and attention

LONGITUDINAL SECTIONAL OF PROPOSED INLET AND OUTLET CANALS FROM PLATE XVI. OF THE PLANS OF THE RESERVOIR DEPARTMENT, EGYPT.

Draughted by W. Willcocks, M. I. C. E., Director-General of Reservoirs.



Estimates by Mr. Willcocks of Excavation in cubic metres.

[True cost $1,000.]			[No such canal is required.]		
Sand - - - - -	602,000	Marl - - - - - -	7,592,000	Clay - - - - -	6,996,000
Rock - - - - - -	3,792,900	Rock - - - - - -	4,582,000		
Cost - - - - -	$1,516,800	Cost - - - - - -	$3,730,800	Cost - - - - -	$1,896,000

NOTE.—The dotted horizontal line has been added to the original plate.

The names Masaigega and Liernur were substituted by Mr. Willcocks, in 1894, for those given by Mr. Cope Whitehouse, which had been approved by the Egyptian government in 1888, accepted by cartographers, and officially adopted by the British war office and the Italian ministry of agriculture.

Surface of reservoir at R. L. 30, 727,000,000 square metres. Contents of Raiyan Reservoir between R. L. 23 and R. L. 30, 4,711,000,000 cubic metres.
at R. L. 23, 607,000,000 " " Contents of Assouan Reservoir - - - - 928,000,000 " "
Estimated cost of Assouan Reservoir (as amended) $6,500,000.

by Sir C. C. Scott Moncrieff and Colonel Ross, who, as you are aware, are the responsible advisers of the Khedivial government in such matters."

A great irrigation work in a foreign country is like a masterpiece in an alien tongue. Its plans cannot be transferred to another place without grave risk. Each irrigation problem stands by itself, governed by local conditions; and the form as well as the position of a dam must be controlled by the physical factors peculiar to the spot. Each river has its own life. The catchment-basin of its source and the influences of its early career must be studied. The engineer who is set to train a Kanawha or equalize the flow of a Rio Grande knows that he must conciliate nature, and rather seek to induce the forces at his limited disposal to combine and assume a new, but still natural, form, than to treat the tremendous energy and ceaseless activity of a river as if it were like the imprisoned force of water, heated or superheated, in its steel cell.

The Anglo-Indian engineers in Egypt have proposed their solution of the Nile problem. The details of their plans are useful subjects of study. They have been shown how the engineers of a far-off period met the same difficulties, and accomplished stupendous results in the development of the country to an ideal standard. The stability given to their works is an object-lesson of supreme importance. It is not, perhaps, to be expected that the engineer of a private company should attach too much value to such a length of life as that enjoyed by the Bahr Jusuf. The government and municipal corporations, however, are borrowing money to be repaid by posterity. Their engineers may rightly be asked: What is the probable life of your proposed dam? How long would your canal continue to supply the wants of the population dependent upon it, if in the ebb of civilization no thought or money were employed upon it for centuries? If, in the recurring cycles of engineering enterprise, it should be found necessary to obtain the maximum of work from these forces, will anyone claim, four thousand years hence, that your scheme in its entirety was the best possible, and propose, for an expenditure not amounting to one per cent. of the original outlay, to bring it to its previous state of highest efficiency?

The engineer who accomplishes this in the American Sahara will have written his name with water in sand. The phrase fails in its proverbial application. His fame will endure in the perennial stream of life-giving water and fertile fields; while the bronze of the victor in internecine conflict proves only the fleeting record of a moment.

THE PROFESSIONAL MECHANICAL INVENTOR.

By Henry Harrison Suplee, M. E.

THERE is probably no more pathetic figure in the whole range of fact or fiction than that of the old-time visionary inventor, filled with the one idea of his great discovery,—great to him, but nearly always nothing or less than nothing to others. All of us have heard of him, many of us have known him, and the story of his struggles and trials, his failures and successes, may be read by those who have never met him, if they will take a thoughtful walk through the model rooms of the patent office or turn the leaves of back numbers of the *Gazette*.

There seems to have been a strange fatality about the early history of the development of applied mechanics, not unlike that of the curiously empirical art of alchemy, from which indeed modern chemistry has been developed; but chemistry, as a scientific study and application of the natural laws of molecular composition and decomposition, has had a definite existence since the beginning of the century now drawing to its close, while the application of the science of controlled motion to the utilization of the mechanical forces of nature is even yet denied by many to be a practical possibility. Nevertheless the science of invention, if we may have the temerity even now to call it a science, has reached a stage in its progress where it has found both employers and exploiters, and it is now no longer a dubious compliment for a man to be called an inventor, especially if it be known that the methodical, business-like person to whom the title is applied is retained at a comfortable salary by a powerful corporation or is reaping a substantial harvest of royalties from the products of his inventive ability.

"Science," as Brougham has tersely defined it, "is knowledge reduced to a system," and, if ever any mass of knowledge has been waiting to be reduced to a system, it is the vast, unclassified, almost unrecorded accumulation of experimental knowledge, successful and unsuccessful, which for so long has been paraded before the earnest student of applied mechanics under the misnomer of "practice." Reuleaux has rightly said that "theory and *practice* are not antagonistic, as is often tacitly assumed. The popular antithesis should rather be between theory and *empiricism*." It was as the product of empiricism, often indeed successful, but far more frequently the reverse, that the title of inventor acquired its one-time questionable repute; it is as the result of the practical application of theory, com-

bined with the scarcely yet known art of cultivated observation, and verified by systematic records of past experience, that this title has been turned from a reproach to an honor, and that invention has become a legitimate profession with its specialists in every branch.

There can be no doubt that the too well deserved repute of the inventor for general unreliability was largely due to his empirical methods. The old rule of "cut and try" was the general one, and the application of scientific analysis the rare exception. A most striking illustration is found in the transformation of public opinion with regard to inventors of so-called "flying-machines." Nearly all inventors were formerly supposed to be more or less weak in the "upper story," but, if it became known that any man, however intelligent or scientific, was at work upon a *flying machine*, his reputation for sanity was endangered almost beyond hope of salvation. To-day we have the ablest engineers, mechanics, and physicists studying the problem with all the ability which modern training can give, and lo! public opinion promptly trims to meet the new conditions, and awaits results with rather impatient expectation. This is but a single example of the changed attitude of public opinion, and, like many changes, it has been carried rather too far by some; for it must not be supposed for an instant that any system of originating inventions can be devised which will dispense with the genius of the inventor. Rather is it desired to place mechanical invention in the same plane as invention in other branches of human originality, so that the inventor may receive a special training, just as the musician is trained in the science of musical composition, or the poet in the rules of metrical rhythm; not to give the ideas,—these must come from the intuition of the brain,—but to enable the conceptions to be shaped, so to speak, in the most available and correct form without innumerable trials.

The study of theoretical kinematics, or the science of controlled motion, may be compared to that of analytical chemistry, in which the given article, whether machine or compound, is picked to pieces and its composition determined and studied. This is often useful and desirable in both lines of work, but, in mechanical subjects at least, the charge has been made, and with some degree of justice, that the professor is always just too late, and does not tell you how to do it until you have discovered it without him. In chemistry, however, the synthetic branch is being actively exploited, with important present results, and tremendous possibilities in sight. Synthetic kinematics is as yet hardly more than a name, although, as a branch of the applied subject, it is taught with gratifying results at Charlottenburg, and indeed used by many elsewhere who have had to work out the principles for themselves.

Again it must be emphasized that no system can take the place of individual inventive genius, any more than a knowledge of the science of musical composition can make a man a composer; but for the professional inventor, who is retained to develop subjects laid before him, or rather to invent devices to accomplish ends required of him, the science of combining mechanical ideas has become an absolute necessity. To speak in a parable, the science of applied kinematics may be likened to the now famous Bertillon system of identification of individuals, each subject being classed in some one of a few great groups, determined by corresponding peculiarities, and these groups being then gradually sorted into lesser and lesser groups, until there are left but a few possible examples from which selection may be made. The difference between the two systems, however, is a most important one, applied kinematics proceeding in an order exactly the reverse of that employed by the Bertillon identification system. Instead of trying to identify the individual with the record, the problem in connection with invention is to find from the record a combination, or set of combinations, which will meet, to a more or less satisfactory extent, the especial requirements of the case under consideration.

This naturally presupposes the existence of a record so classified as to enable the weeding-out of combinations not readily and definitely available for the purpose in hand, and to which new fundamental chains of mechanism may be added should the advance of discovery make it necessary. It is just such a record which, while lacking tables, dictionaries, or indices, may be made by every man for his own work from his own experiences and from those of others in his especial line, by proper study and use of the methods of theoretical and applied kinematics; and, while this branch of knowledge, as has been already said, has not yet been fully reduced to a system, much has been and is being done in this direction.

But, it may be asked, what has all this to do with the subject of this paper? Simply that it is to the actual and extending use of the principles above indicated that the profession of invention owes its development from the empirical and uncertain status of the recent past to its present repute. Nothwithstanding the fact that there has as yet been little or no training of inventors in the methods of applied kinematics, and the fact that the notations and classifications which have been so ably devised by Professor Reuleaux are just beginning to be appreciated, the methods upon which the system is based have, to a greater or less extent, been actually used by nearly all those who have successfully developed the profession of invention, and are doubtless destined to be more and more extensively used in the future.

A system in itself, however, is of but little value without the capacity

to use it, and without ideas to which it may be applied. These, every one will at once say, cannot be made to order, or furnished upon call; and it is true of invention, as Archimedes long ago said of mathematics, that there is no royal road by which it can be reached. But it may not be amiss to note that there are no royal roads anywhere at the present time; and the monarchs of to-day, when they wish to reach desirable places, usually travel over the same railways as do the multitude. A man must indeed have money enough to buy his ticket if he expects to remain on the train, and the would-be inventor must have brains enough to pay his passage, or he has indeed mistaken his vocation. Having the ideas,—that is, the means, to follow the simile a little further,—he would be indeed foolish to tramp across country when he might instead use the railway; and to plead unwillingness to take the trouble to learn the use of time-tables and study railway maps would be about as intelligent a proceeding in the one case as to object to learning the use of a new nomenclature and system in the other.

When the modern inventor undertakes to produce a device to order, so to speak, the usual and sensible manner of beginning is to inform himself as fully as possible of the end to be accomplished, and, unless the problem is entirely a new one, to find out what plans have been already employed by others for the same or similar purposes. Here at once the difference between the older and the later methods appears. Formerly an idea occurred to a man, and he forthwith proceeded to "complete" the invention, often entirely unaware whether or not anyone really needed such a device, and usually blissfully ignorant as to what others had already done, or failed to do, in the same field.

An instance quite in point in this respect may be given, in which an ingenious mechanic invented an elaborate apparatus for finishing at one operation a number of holes in a rather irregular casting, these holes being intended to receive the ends of wrought-iron tubes afterwards to be secured by expansion, forming steam-tight joints. When the device was submitted to the concern to which the inventor hoped to sell it, he discovered to his chagrin that the castings were so perfectly made that no finishing at all was necessary, and that the tubes could readily be expanded tightly and satisfactorily in the unfinished holes without the use of his or any other device.

In many other cases a careful examination of the field discloses the causes of failure of previous inventions, confirming again and again the trite, but too often forgotten, saying that almost as much may be learned from failures as from successes. Some day people will realize the importance, not of keeping a record of "how not to do it," but of how people have failed to do it; and, as a danger signal is placed by

the hole in the ice to warn off the skater, so precautions may be taken to avoid the very thin ice in some other directions.

Our professional inventor, then, must keep himself posted as to the state of the art in which his specialties lie, always scanning closely the issues of the various patent-office publications, watching the technical journals, and generally keeping his eyes open. This branch of his profession is not unlike that of the skilful detective, in that it demands the same habit of close observation and the same exercise of a highly cultivated and available memory. It has been said "that most people observe only enough to find their way about, and to recognize their friends"; and, although this was intended to be applied to perception in matters of art, it is none the less true in the world of mechanics. As the detective must constantly observe and remember the multitude of every-day occurrences going on all about him, never knowing what little ordinary fact may become the clue to some important event, so the man whose business it is to make inventions to order may and does train his faculties of observation and memory to an extent which sometimes appears extraordinary to the uninitiated person, as does the perception of a Sherlock Holmes in reading the really obvious meaning of a succession of quite ordinary events. This part of the work, while not really invention in any sense, forms a large portion of that record of systematized knowledge upon which the science is based, and many a professional inventor can draw from his trained memory, almost at once, data which will enable the practicability or impracticability of a proposed device to be determined. When such immediate handling of the subject is not possible, the more difficult and thorough attack upon the problem must be made. Copies of previous patents relating to the subject in hand are procured and compared, catalogues of various manufacturers are consulted, and with the field thus cleared very many of the obstacles and errors formerly inevitable are avoided. Then follows an analysis of the determinate motions which are required of the machine, these being either given conditions of the problem or directly deducible from the work or product required of it. When with these are combined the questions of the possible methods of operation and limiting features of construction, it is generally found that among the few solutions practicable the selection of the one which meets the commercial side of the case is fairly placed before the court, so to speak.

By this time drawings, first in the form of sketches, followed by calculations of stress and strain, are in order; and the matter almost inappreciably passes from the realm of invention into the broad daylight of machine-design; and, when the inventor finally proceeds to prepare the data for the patent attorney, he sometimes is

rather uncertain as to just where the description ends and the rigid facts for the "claims" begin. Often this portion of the work involves the construction of models and the making of experiments, but these are very different from the experimenting and model-making of the old-time inventor. The man who formerly thought he had invented a flying machine proceeded to try to whittle one out and make it fly; to-day the secretary of the Smithsonian Institution makes a series of experiments to determine the data necessary to the ascertainment of the relations of the supporting action of the air to the velocity of aero-planes, while Mr. Maxim experiments as well upon the supporting power of screws and also the problem of reducing the weight of the motor; and these investigations, which in themselves involve no invention,—in the sense of the absolute production of something essentially novel,—will doubtless, when combined with the results of similar researches of many able investigators, make it possible to produce, in the designing-room of almost any first-class machine shop in the land, a machine which will navigate the air.

Of course there are other questions besides those of a purely mechanical nature which must enter into the success or failure of an invention. Many a device has been perfect mechanically and useless commercially for reasons of a purely business nature, and there seems to be a firmly-rooted impression in many minds that an inventor cannot possibly be a good man of business also. That idea, however, is being gradually removed, and, with his advance to the status of a professional man, the inventor has promptly grasped the business end of the situation as well. We have referred already to the poor inventor of whom we have read in so many stories, and most of us remember that in these stories there was always a grasping capitalist, and the plot nearly always hinged upon the schemes of the man of money to possess himself of the ideas of the man of brains at a trifling price, the latter individual generally being as innocent in matters of business as he was skilled in matters mechanical. The modern inventor must be a business man as well as a man of mechanical ideas; and, in fact, the systematic methods of modern invention are really based upon the same fundamental laws as those of business, and the relation of the professional inventor to his employer to-day are much more like those of the lawyer to his client than almost any business relation we might name.

Having thus briefly glanced at the changed relations of the inventor to the public and to the world of business, and the existence of the profession of invention, properly so-called, let us examine, also very briefly, the relative importance of this profession as compared with other branches of creative industry. The subject of social economy

was formerly divided into the branches of production, distribution, and consumption, and under the first head was included only what we may here call, for lack of a better name, material production. Mr. Ruskin, however, long ago pointed out, in his "Political Economy of Art," that the creations of the mind may often be far more valuable, in the most rigid commercial sense, than many products of a far greater material cost. A poor artist three hundred years ago painted some frescoes on the wall of an Italian palace, another chiseled a statue from a long-neglected block of marble, and to-day an American steamship company pays a dividend because the army of travelers from a land, then inhabited by savages, throngs across the ocean to see the remains of an art that money cannot buy nor modern training produce.

So too we may claim for the science of mechanical invention a place in the mental production of wealth of nations even greater than that of art. The systematic control of the powers of nature—a control which can only be attained by the systematic attack of the trained inventor—is adding to the wealth of the world in a proportion which will ever increase and which ultimately will exceed that from all other sources combined. Just as the leader of modern synthetic chemistry does not hesitate to predict that before a great lapse of time we shall produce in the laboratory directly from the materials of the earth all necessary and desirable food products, independently of vegetable and animal growth, so too it may safely be predicted that the other material wants of man will be attained solely by the control of natural forces, in quantity amply sufficient for the needs of all. It is only the natural perversity of man which has led him to devote the initial efforts of systematized invention towards destruction, but the enormous development of the art of war and of the materials and methods of attack and defence is in itself sufficient demonstration of the results which concentrated thought in any mechanical line can accomplish. This abnormal application of the subject is, however, only the natural historical sequence of affairs, and must work its own remedy. In the meantime it is only necessary to watch and await the results of the action of the silent but mighty forces which are being evoked in the quiet rooms where thoughtful men, trained in the art of developing mechanical ideas, are spending the best hours of their lives; and, as the coming century passes into history, the place of honor to which it will be entitled will be due, not to the men who have taught and worked destruction, but to the noble army of inventors and the mighty industries throughout all the world.

STEAMBOATS OF THE RIVER HUDSON.

By Samuel Ward Stanton.

WHEN the sun rose on August 8, 1807, its rays lit up the decks of a craft that was slowly ploughing the waters of the Hudson, somewhere above the historic Highlands in the vicinity of Newburgh Bay. Contrary to all established rules, she was moving steadily along against tide and wind. From a tall stack huge volumes of smoke poured incessantly, and the inhabitants of the houses on the banks as well as the captains and others on board of the numerous passing sloops gazed with open-mouthed wonder at the strange spectacle of what appeared to them to be moving mill-wheels on the sides of the boat.

The vessel was the steamboat Clermont. She had left the city of New York the day before at one o'clock in the afternoon, and, at a speed of nearly five miles an hour, had covered the distance between the metropolis and that part of the river through which she was passing, and this by the use of steam alone.

On board, and directing her movements, was Robert Fulton, who, while not the inventor of the steamboat, was the man to whom the world owes unquestionable gratitude, as having been the first to comprehend the great possibilities of the use of steam for propelling vessels by means of paddle-wheels, and for putting into operation the only successful steamboat that had ever been projected.

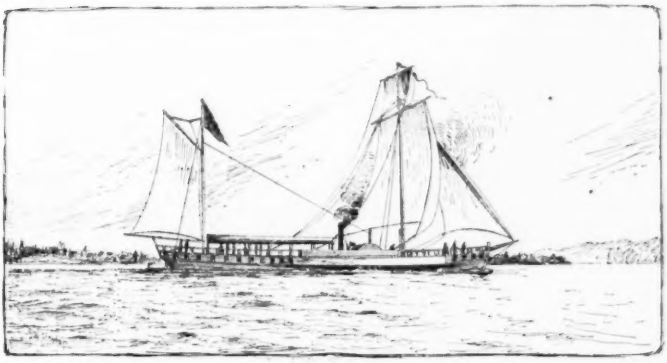
The Clermont had on board a number of Mr. Fulton's guests, and at one o'clock in the afternoon she stopped at "Clermont," the country seat of Chancellor Livingston, where she remained until the next day. The distance from New York was one hundred and ten miles, and the little boat had covered it in just twenty-four hours. On Wednesday she started from the chancellor's at nine o'clock in the morning, and arrived at Albany at five o'clock in the afternoon, the distance being forty miles. The whole trip had been made in thirty-two hours. The following morning she left Albany at nine o'clock, and went to New York in thirty hours. Fulton said, in an account of the trip: "No advantage could be derived from my sails. The whole voyage has therefore been performed by the power of my steam-engine."

On her first trip up the river as a packet-boat there were twenty-four passengers on board; she continued to carry a good passenger list on every trip throughout the season. During the following winter the Clermont was made longer and broader; with her name changed to

PROMINENT HUDSON RIVER STEAMBOATS 1807-1895

Compiled & Arranged by S. W. Stanton

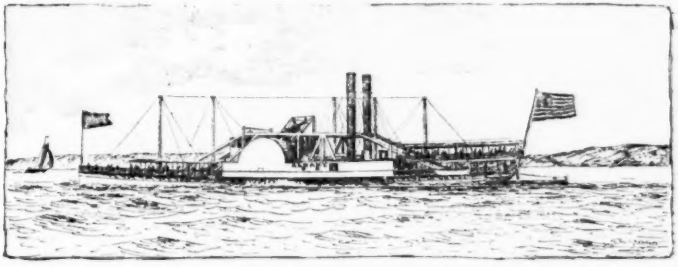
NAME	BUILT	CONSTRUCTED BY	AT	TONNAGE	LENGTH	BREADTH	DEPTH	ENGINE BUILT BY	CYLINDER DIAMETER	STROKE	ROUTE	REMARKS
CLERMONT	1807	Charles Brown	New York		133'	18'	7'	Boulton & Watt	24"	4'	N.Y and Albany	Lengthened 1808 and 1811, engine & boiler placed
CAR OF NEPTUNE	1808	do	do	295	175	24	6	–	33	4' 6"	do	Broken up
PARAGON	1811	do	do	331	173	27	9	–	32	4'	do	Struck a rock and sunk near Albany
HOPE	1811	–	–	180	–	–	–	–	–	–	do	Had rank in TRADEWATER, 1808 Broken up
FIRE FLY	1812	Charles Brown	New York	118	100	19	7	Robert McQueen	20	3' 9"	N.Y and Newburgh	Broken up
LADY RICHMOND	1813	–	–	370	–	–	–	–	–	–	N.Y and Albany	Broken up about 1830
OLIVE BRANCH	1815	–	–	295	122	30	–	–	40	6	do	Built for N.Y and New Brunswick trade Broken up
CHANCELLOR LIVINGSTON	1816	Henry Eckford	New York	495	157	33½	10	James P. Allaire	44	5	do	Placed on J. Sound 1824, Raised and renamed ST.
UNITED STATES	1821	J. Williams	do	160	140	–	–	–	–	–	do	N.Y & New Haven route, afterwards tow-boat at Albany
JAMES KENT	1823	Blossom, Smith & Dimon	do	364	140	48	–	–	–	–	do	State boat on North River 1834
CONSTITUTION	1826	Brown & Bell	do	275	145	29	–	–	42	9	do	Altered into tow-boat name CLINTON, Broken up
CONSTELLATION	1826	do	do	275	149	27	–	–	44	10	do	Dismantled and engine taken to Lake Erie
COMMERCE	1825	C. Bergh	Brooklyn	371	130	24	8½	–	16 & 30	4	do	Altered 1832 and named UNITED, Broken up 1839
SWIFTSURE	1825	do	do	265	130	24	8½	–	16 & 30	4	do	Altered into tow-boat, Broken up
NEW PHILADELPHIA	1826	–	–	300	170	24	–	–	55	10	do	Altered into tow-boat, Broken up
INDEPENDENCE	1827	Brown & Bell	New York	368	148	26	–	–	44	10	do	Altered into tow-boat, Broken up
ALBANY	1827	J. Vaughn	Philadelphia	298	212	26	9	–	65	9	do	Lengthened 1839 to 239 feet, Broken up
NORTH AMERICA	1827	William Capes	New York	497	216	30	8	–	44	8	do	Two boilers, sunk by ice 1832
VICTORY	1827	M. Kenyon	Albany	290	–	–	–	–	–	–	do	Altered into tow-boat, Sunk 1845
DE WITT CLINTON	1828	do	do	571	233	28	10	–	66	10	do	Broken up
OHIO	1828	–	–	412	192	30	–	–	60	9	do	Destroyed, Broken up
NOVELTY	1830	William Brown	Hyde Park	450	165	24	9	–	60	9	do	Broken up
ERIE	1832	Brown & Bell	New York	471	180	28	9	West Point Foundry	44	10	do	Lengthened 32 feet, 2 engines, (2 boilers + 1854)
CHAMPLAIN	1832	do	do	471	180	28	9	do	44	10	N.Y and Troy	Two engines & one boiler to, engine placed in 1854
WEST CHESTER	1833	Smith & Dimon	do	230	–	–	–	–	42	10	do	Made to ERIE, Broken up
ROBERT L. STEVENS	1835	–	Kingston	268	175	24	–	–	–	–	do	N.Y and Albany
HIGHLANDER	1838	Lawrence & Sneeden	New York	313	175	24	8	–	36	10	do	Altered into tow-boat, named HUDSON, Broken up
SWALLOW	1836	William Capes	Brooklyn	426	224	22	8¾	West Point Foundry	41	10	do	Broken up, engine placed in CHAMPLAIN 1838
ROCHESTER	1836	Smith & Dimon	New York	481	208	24	8¾	West Point Foundry	46	10	N.Y and Albany	Sent to Delaware River, Broken up
UTICA	1837	William Capes	Brooklyn	340	180	21¾	8½	do	43	10	N.Y and Troy	Last April 7, 1845, over 150 persons perished
BALLOON	1839	Devine Buttis	do	204	160	18	7¾	James Cunningham	28	11	N.Y and Albany	Broken up
NORTH AMERICA	1839	–	–	494	230	26	9	James Cunningham	48	11	Pokeepsie & Albany	Altered into tow-boat, condemned 1875
SOUTH AMERICA	1840	–	–	638	260	26	9¾	do	54	11	N.Y and Albany	Broken up on Delaware River
TROY	1841	–	Brooklyn	724	294	61	–	West Point Foundry	44	10	N.Y and Troy	Broken up, engine placed in 152 UNDINE
EMPIRE	1843	–	–	836	–	–	–	W.A. Lighthall	–	–	do	Engines from ERIE, placed New, Broken up
NIAGARA	1844	George Collyer	New York	688	265	24½	9¾	Hogg & Delamater	60	11	do	Destroyed in July 8, 1853
IRON WITCH	1844	Hogg & Delamater	New York	–	225	27	13	do	–	–	do	Altered into tow-boat, Broken up
RIP VAN WINKLE	1845	George Collyer	do	334	242	25	8	W.A. Lighthall	50	10	N.Y and Albany	Name changed to ERIE, made tow-boat, Broken up
HENDRICK HUDSON	1845	–	–	1170	320	35	9½	do	72	11	do	Burned at Albany, April 6, 1872
OREGON	1845	–	–	1050	310	35	10	Shillman, Allen & Co	72	11	do	Broken up
THOMAS POWELL	1846	Lawrence & Sneeden	New York	585	231	28	9	T.F. Secor & Co	48	11	do	Lost
ISAAC NEWTON	1846	William H. Brown	do	1332	338	40	10½	Allaire Works	81½	12	N.Y and Newburgh	Broken up
ALIDA	1847	do	do	640	265	30	10	Henry R. Dunham & Co	56	12	N.Y and Albany	Lengthened 1854 to 348 feet, Burned Jan 3, 1865
ARMENIA	1847	Thomas Collyer	do	398	185	28	8	do	40	14	do	Altered into tow-boat, Broken up
NEW WORLD	1847	William H. Brown	do	1418	385	35	11	T.F. Secor & Co	76	15	do	Went to Rebuilt River 1853, Burned Jan 3 1865
FRANCIS SKIDDY	1848	George Collyer	New York	1335	322	38	11½	Jas Cunningham & Co	71	14	do	Engine put in 37 1857, Broken up
DANIEL DREW	1850	Thomas Collyer	do	880	251	30	9¾	Neptune Iron Works	60	10	do	Arrested Nov 3, 1854, engine in 1861 Rebuilt
JAMES W. BALDWIN	1851	M.S. Allison	Jersey City	770	262	34	9	Fletcher, Harrison & Co	60	11	N.Y and Rondout	Burned August 29 1856
MARY POWELL	1861	do	do	983	260	34½	10¾	do	60	11	do	Lengthened to 215 feet, running 1894
THOMAS CORNELL	1863	E.S. Whitlock	Brooklyn	1256	310	34	–	–	72	12	do	Lengthened to 300 feet, running 1894
BERKSHIRE	1863	Morlan & Edmonds	Athens	–	253	37	10	–	72	12	do	Wrecked on Feb 21, 1882
ST. JOHN	1863	John Englis	Brooklyn	2645	420	51	10	James Cunningham	54	11	N.Y and Hudson	Burned June 8, 1864, 40 persons lost
CHAUNCEY VIBBARD	1864	Lawrence & Sneeden	do	1158	281	35	9	T.F. Secor & Co	76	15	N.Y and Albany	Largest boat that ever ran on river, Burned Jan 24, 1876
DEAN RICHMOND	1864	John Englis	Greenpoint	2525	348	46	10	Jas. Cunningham & Co	75	14	do	Between Boat on Delaware River 1894
MUPHA	1865	J.S. Baldwin	New Baltimore	1232	253	37	10	Fletcher, Harrison & Co	37	5	do	Running 1894
DREW	1866	John Englis	Greenpoint	2902	366	47	10	–	–	–	N.Y and Hudson	Propeller, running, as METROPOLITAN, 1895
CITY OF TROY	1876	do	do	1572	300	36	10	–	66	12	N.Y and Albany	Largest number of any N.R. boat, running 1894
SARATOGA	1877	do	do	1436	300	36	10	T.F. Secor & Co	60	12	N.Y and Troy	Running 1894
CITY OF CATSKILL	1880	Van Loan & Magee	Athens	–	250	35	10	W. & A. Fletcher	60	12	do	Running 1894
ALBANY	1880	Morlan & Hollingsworth Co	Wilmington, Del	1615	295	40	11½	do	56	12	N.Y and Catskill	Burned February, 1883
KAATERSKILL	1882	Van Loan & Magee	Athens	1361	281	38	10	do	73	12	N.Y and Albany	Lengthened 1893 to 325 feet, running 1894
CITY OF KINGSTON	1884	Morlan & Hollingsworth Co	Wilmington	1117	250	33¾	12½	do	63	12	N.Y and Catskill	Running 1894
NEWBURGH	1886	Neafie & Levy	Philadelphia	1033	210	32	13½	Morlan & Hollingsworth Co	30 & 56	3	N.Y and Rondout	Propeller, built 1885 for service on Pacific Coast
HOMER RAMSDELL	1887	T.S. Marvel & Co	Newburgh	1181	212	32¾	11	Neafie & Levy	26 & 45	3	N.Y and Newburgh	Propeller, running 1895
NEW YORK	1887	Morlan & Hollingsworth Co	Wilmington	1552	311	40	12½	William Wright	26 & 52	3	do	Propeller, lengthened 1891, to 231 feet, running 1895
								W. & A. Fletcher	76	12	N.Y and Albany	Running 1894



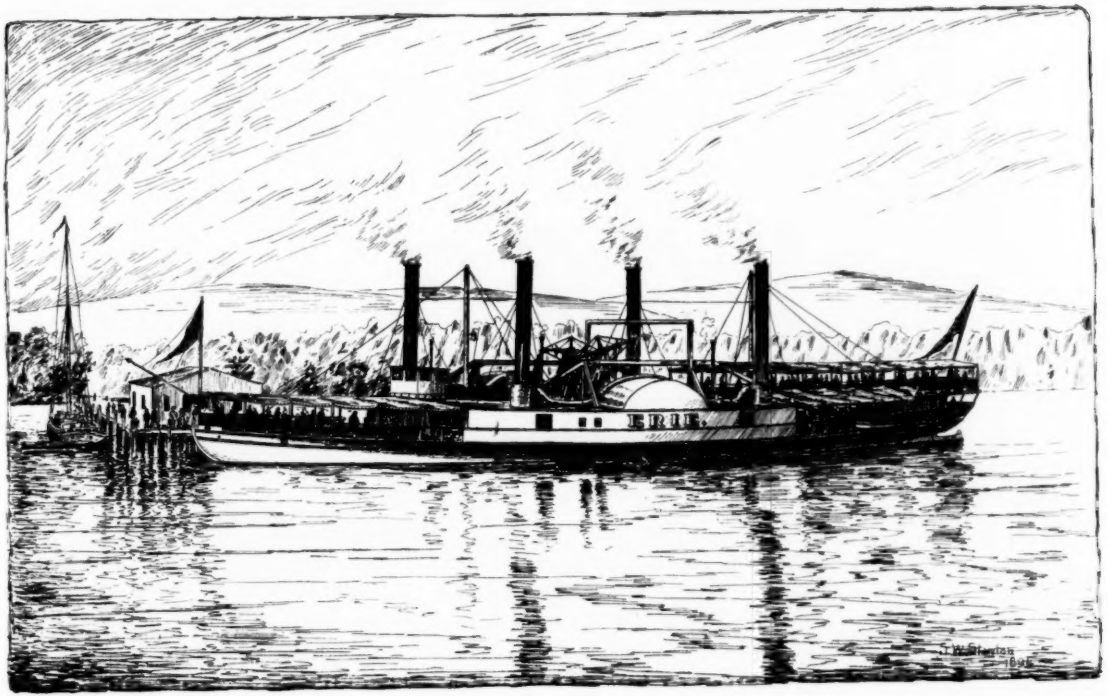
PARAGON.

North River, she began her trips again in the spring, and for several years was used continuously. In the New York *Evening Post* of November 9, 1809, the following appeared: "The North River steamboat arrived this afternoon in twenty-seven and one-half hours from Albany, with sixty passengers."

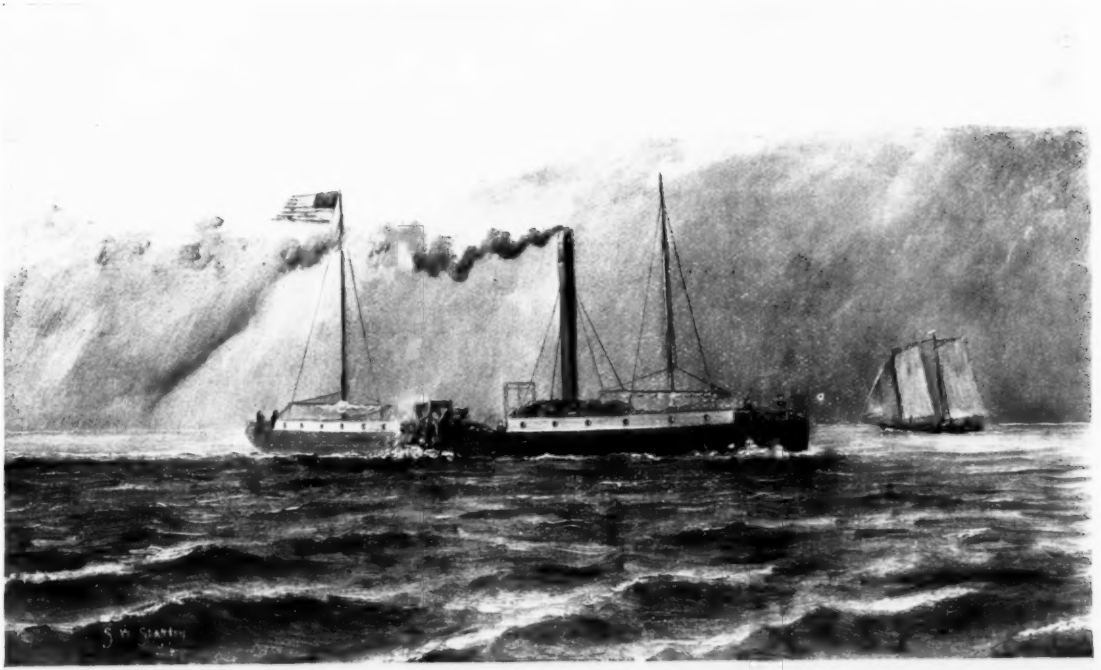
Travel by steamboat becoming so popular that the Clermont could not accommodate the crowds that desired to avail themselves of this mode of conveyance, a new boat was contracted for. This was the Car of Neptune, built in 1807–8 by Charles Brown. These two boats were able to perform the work satisfactorily for several years. In 1811 the Paragon appeared; she was two feet shorter than the Car of Neptune, but was of greater beam and larger tonnage. Two opposition steamboats, the Hope and Perseverance, were placed on the river in 1811, but were forced to withdraw from the business on account of the exclusive privilege given to the Fulton and Livingston Line to navi-



ALBANY.



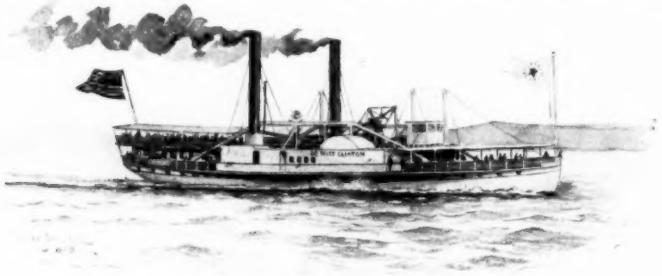
ERIE.



CLERMONT.

gate the waters of New York State. Following the Paragon, of the regular line, came the Fire Fly, a small boat, built for the lower river trade, in 1812, after which came the Lady Richmond, one of the best boats that had yet been constructed.

In 1816 appeared the Chancellor Livingston, an important Hudson River boat and the most wonderful steam vessel of early times. She was designed by Mr. Stoudinger, a naval architect of no mean ability at that date, and was gotten up regardless of cost. Her hull was constructed by Henry Eckford, and the joiner-work executed under the direction of David Cook. The engine, by James P. Allaire, was undoubtedly the finest that had yet been constructed in this country, and the boiler—of copper, and weighing about forty-four thousand pounds—was of a new model. She was the first steamboat having a cabin on the main deck, with a promenade above, and her total cost was $11,000. She was much the speediest of the river boats, and on her



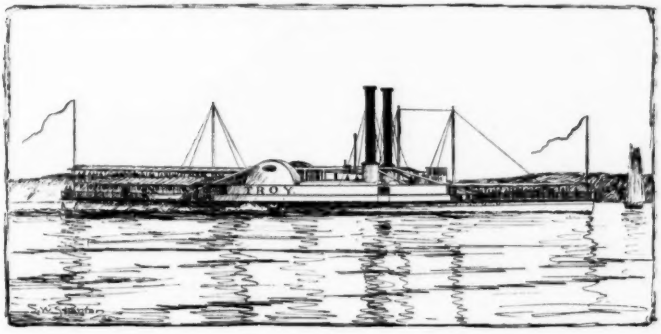
DE WITT CLINTON.

trial trip, which occurred Saturday, March 29, 1817, she ran to Newburgh, a distance of sixty miles, "in a few minutes less than nine hours, of which time the tide was in her favor only three hours. In returning, the same distance was run in eight hours and fifteen minutes, the greater part of the time against a flood tide and south wind." The calculations were that she would go to Albany in about twenty hours. On December 5, 1817, she went up in eighteen hours. The Livingston continued to ply on the Hudson until 1828, when she was placed on the Long Island Sound route from New York to Providence.

The North River—or Clermont—having been laid aside, these boats ran as regular packets up and down the river, to the exclusion of all others, the Fulton & Livingston Company having the sole right to navigate the waters of New York State by steam. In June, 1821, however, a new boat, called the United States, and built by William Gibbons, was put on the route from Perth Amboy, N. J., to Albany,

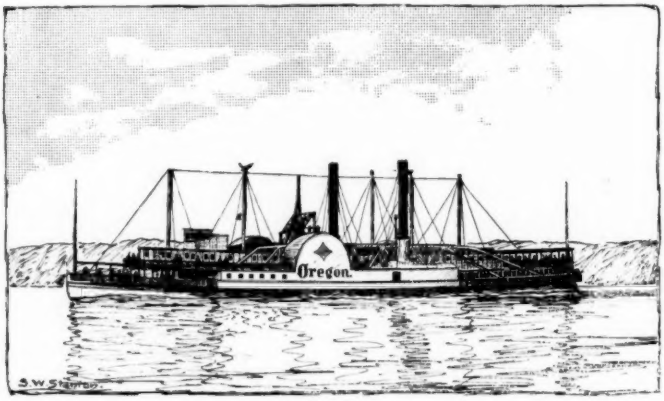
making stops at New York and the Hudson River towns. After a few trips she was compelled by law to stop running, and she was put on the New Haven route, where she ran many years.

The last steamboat built by the old North River Steamboat Company, the James Kent, appeared in 1823. She was thus described in the New York *Statesman* of August 14, 1823: "Yesterday afternoon we had the pleasure of visiting the new and beautiful steamboat, James Kent, now lying at the foot of Liberty street. Her frame is composed entirely of live oak, locust, and cedar. She is copper-fastened, and secured in an extraordinary manner by screw-bolts. She was built by Messrs. Blossom, Smith & Dimon, who have certainly done themselves great credit by this elegant specimen of naval architecture. Her machinery is on a scale so gigantic as apparently to require the anvils, hammers, and sinewy arms of Vulcan and Cyclops to forge its massy wheels, bolts, and bars. The boiler is of copper, unusually thick and



TROY.

strong, weighing upwards of thirty tons, and amounting to nearly one-third of the whole expense of the boat. It is planned in such a manner that, if it should happen to burst, the water would immediately be carried through the bottom of the vessel by means of cast-iron tubes, or hollow pillars. The copper was manufactured by the Soho Company. The engine is modelled after the latest and most approved plan of the celebrated Mr. Watts, and was manufactured by the West Point Foundry. It is decidedly one of the finest engines that has yet been made in America, both as to the quality of the castings and the scientific arrangement of the machinery. It occupies an unusually small space, and the workmanship is highly creditable to the manufacturers of our country. The James Kent is finished in a style to comport with the superiority of her essential parts. Few rooms in a



OREGON.

private dwelling surpass her cabins in point of finish, neatness, and elegance, or in richness of furniture.

"The gentlemen's dining-cabin is spacious, airy, and lighted by eight or ten windows above, which may be opened or closed, as the weather may require. A table is extended in a semicircular form quite around the room, nearly into the center of which the stairway leads. The ladies' cabin and drawing-room, the former below and the latter on the deck, exceed in splendor and elegance the gentlemen's apartment. In the sitting-room the curtains are of blue damask, with orange drapery; in the dining-cabin the curtains are embossed crimson moreen, with blue vallons and richly-wrought fringe. The tables are mahogany, and the chairs and settees of birdseye maple, with cane bottoms. The mirrors and other furniture are equally splendid." . .

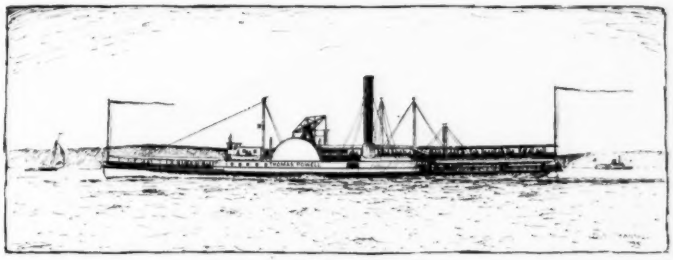
She proved of greater speed than even the Chancellor Livingston. On Monday, May 31, 1824, the James Kent made a remarkably quick passage for those days. She left New York at 5:15 in the morning, and reached Albany at 7:45 at night, having made the passage in fourteen and a half hours, including ten landings. The hull of this boat is still in existence; it is anchored off the Elysian Fields, Hoboken, being used as an anchorage for the tows of the Cornell fleet of boats that arrive and depart from that neighborhood. It is without doubt the oldest hull of a steam vessel in existence to-day.

It was in 1824 that the famous steamboat Olive Branch appeared on the scene,—a boat whose owners broke the monopoly of steam navigation so long enjoyed by the Fulton & Livingston Line. She was placed on the New York and Albany route as an independent packet, and, in

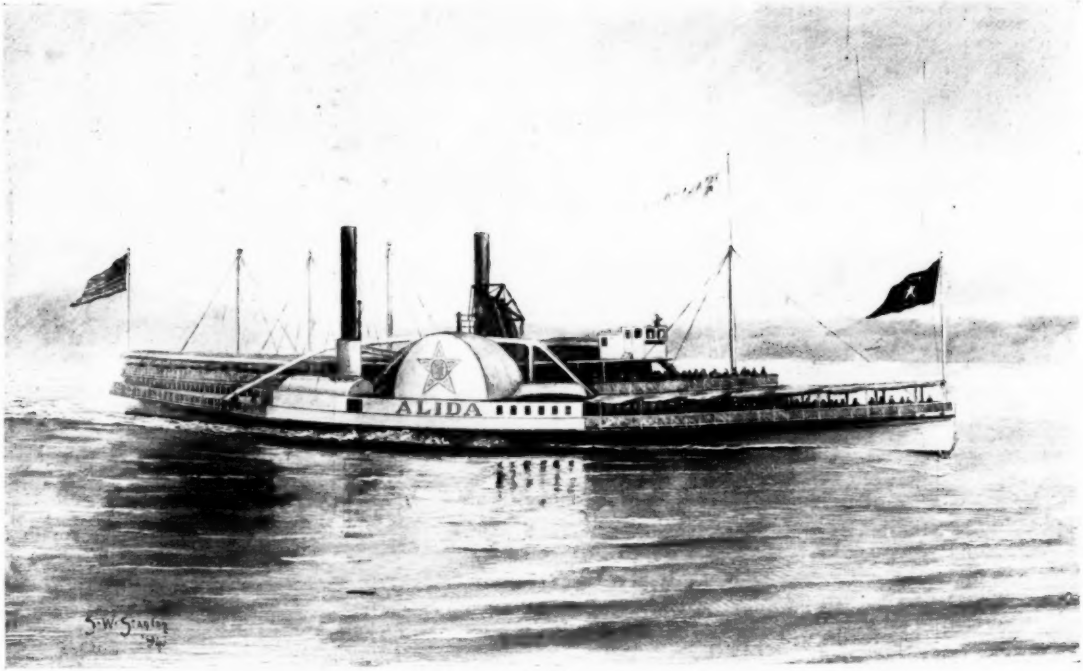
spite of all attempts on the part of the old line to drive her off, she continued to run regularly. In June a decision was reached by the supreme court of the United States and the chancellor of New York State whereby the navigable waters of the country became a free field for all vessels propelled by steam. The Olive Branch was built in 1815, for the New York and New Brunswick route (Philadelphia line), and was a staunch and first-class steamer for her day.

During 1825 many new steamers were placed on the river, all of them being used as passenger boats. The largest and best were the Constitution and Constellation. These two boats were beautifully fitted up, and were not surpassed for comfort or convenience by any for many years. Numerous explosions having taken place on American steamboats during these early days, many persons were exceedingly wary about patronizing vessels propelled by steam. A company was formed in 1825 which had constructed two steamboats and two passenger barges,—the latter termed "safety barges,"—and these ran on the river for a number of years. The steamboat Commerce towed the Lady Clinton, and the Swiftsure the Lady Van Rensselaer, the barges being fastened to the stern of the steamer by means of a bridge, or gang-way, over which the passengers were allowed to pass.

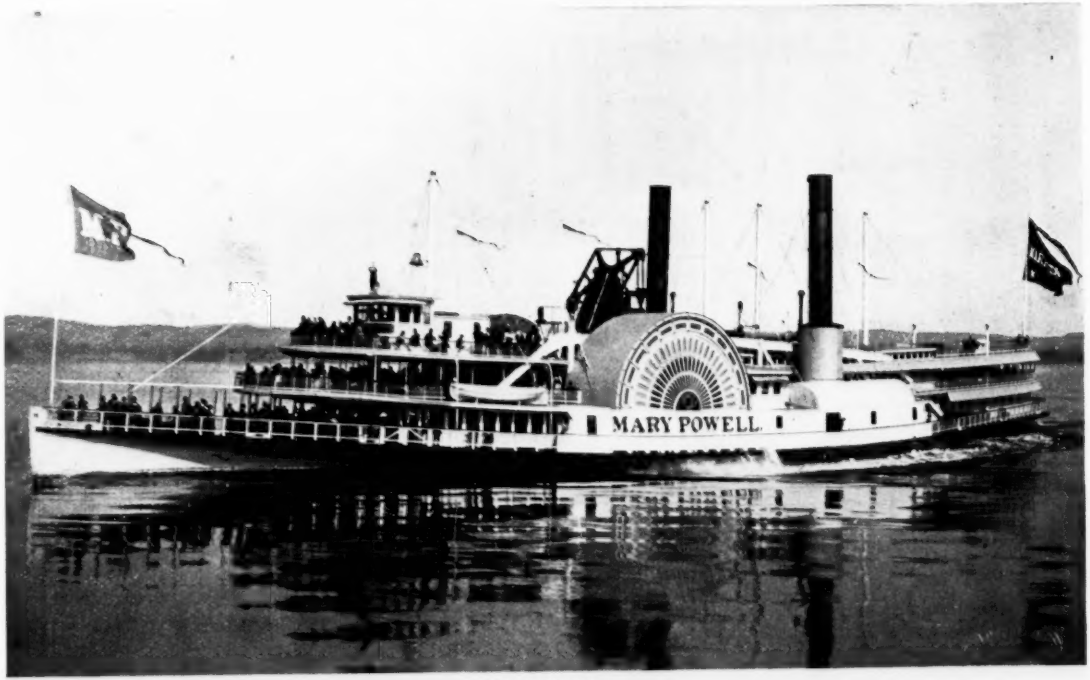
It was in 1826, when the residents along the river were enjoying the advantages of numerous steamboat lines and cheap transportation, that the Messrs. Stevens placed on the river the New Philadelphia, the forerunner of that type of Hudson river steamboat that remained a feature ever after. Her boilers were placed on the guards, aft of the wheels, and her beam engine had many improvements. During the following year the Albany came out, followed by the North America, the latter having the novelty of two beam engines. During 1827–8 the Victory and the De Witt Clinton, two very fine boats, built after the Stevens plan, were constructed at Albany and placed on the river. They were soon purchased by the Stevens line, and for many years this com-



THOMAS POWELL.



ALIDA.



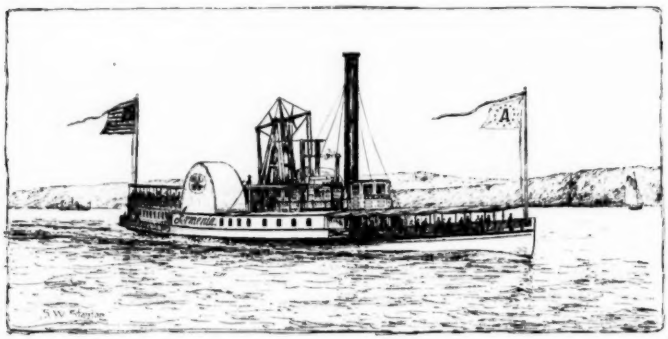
MARY POWELL.

pany enjoyed the almost exclusive monopoly of passenger traffic on the Hudson.

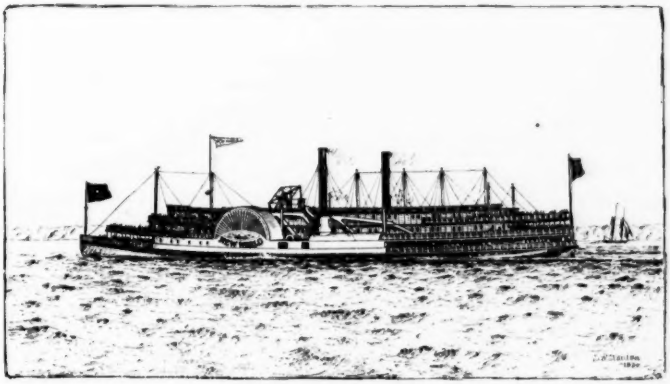
The Novelty, in 1830, was distinguishable as the first steamboat with tubular boilers. In 1832 two large and finely finished steamboats were constructed for the day line. They were the Erie and Champlain, and each boat carried four smoke-stacks and was propelled by two beam engines. These steamboats, like all others of the time, burned wood, and from thirty-five to forty cords were used on the run between New York and Albany. One of the most famous of the early "flyers" of the river was the Swallow, built in 1835.

In that year a new line was started, its establishment growing out of the complaints of the travelling public at the exorbitant rates and other abuses practised by the Hudson River Association, then running the largest fleet and the best boats on the river. The new line was called the "People's Line," and as a proof of its fine management it may be stated that it is still in existence,—the main line between the cities of New York and Albany at the present time. The line was started by Daniel Drew, Capt. St. John, and several others, and their first steamers were the Emerald and Westchester, two purchased boats. The line so quickly grew in popularity that two steamboats were immediately contracted for. These were the Rochester and Utica, which appeared in 1836 and 1837, respectively. The Rochester was the fastest boat that had ever appeared on the river. On June 14, 1837, she made the run from New York to Albany in ten hours and one minute. The Highlander, a smart boat, whose only rival was the Rochester, was built in 1835 for the Newburgh Line.

In 1840 two new steamboats, the North America and South America, were added to the People's Line, and Isaac Newton and his associates



ARMENIA.



NEW WORLD

joined the company. These two vessels were the largest and finest that had yet been built; for many years no vessel could approach in speed the South America. On these boats Isaac Newton successfully introduced the burning of anthracite coal, by which the expense of fuel was reduced at least fifty per cent. below that of the wood-burning boiler. The South America, upon her appearance, was universally acknowledged to be the peer of anything that had ever been put afloat. She was designed by Isaac Newton and James Cunningham. Previous to the building of the North and South America, Newton had designed and had had constructed the famous little river steamer Balloon, a remarkably swift vessel. Her beam engine was the first with long connections, thus allowing her the use of wheels of large size.

The Old Line then built the Troy (1841), the Empire (1843), and the Niagara (1844); the Niagara is still in existence, being used as a towboat. The first iron-hulled steamboat built for the navigation of the Hudson was the Iron Witch (1844),—the only large boat of iron that ran on the river until the advent of the Albany (1880).

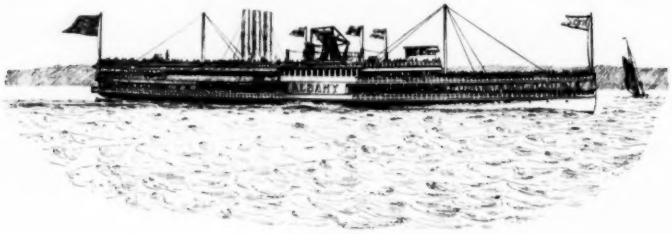
The Oregon (1845), having a speed of over twenty miles an hour, was a perfect river steamer in all respects. The famed New World (1847) was one of the fastest steamers ever built in America; her engine had the enormous piston stroke of 15 feet. On her famous run in 1852, she left New York at 7:10 A. M., made nine landings, each averaging five minutes, and reached Albany at 2:15 P. M., the actual running time being six hours and twenty minutes.

The Thomas Powell, for the Newburgh line, and the Alida, for the day route to Albany, were fine and fast steamers, with a speed of over

twenty miles an hour. The Armenia was a smaller boat, but of excellent model and good speed. In 1852 the last of the great day boats of the early times appeared. This was the Francis Skiddy. It may safely be said that for finish of hull and beauty of lines this boat was the culminating point in Hudson River steamboat building; the art could progress no further.

The Reindeer and Henry Clay, two medium-sized steamboats, appeared the same year as the Francis Skiddy, and could hold their own in speed with anything on the river. The Henry Clay was burned while racing with the Armenia on July 28, 1852, and sixty of her passengers lost their lives.

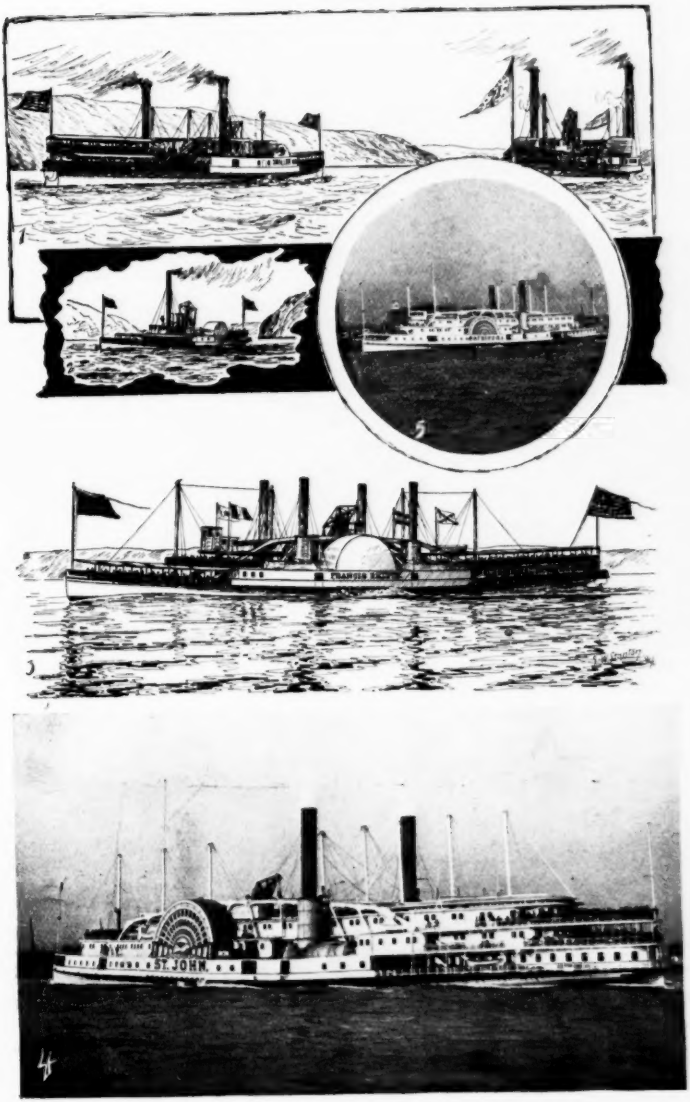
In 1855 the New World and Isaac Newton, built originally for the day line, but which had been for some time unemployed, were changed into night boats. The rebuilding of these vessels was the first step towards those great river palaces—veritable floating hotels—for which America, and especially the Hudson River and Long Island Sound, has



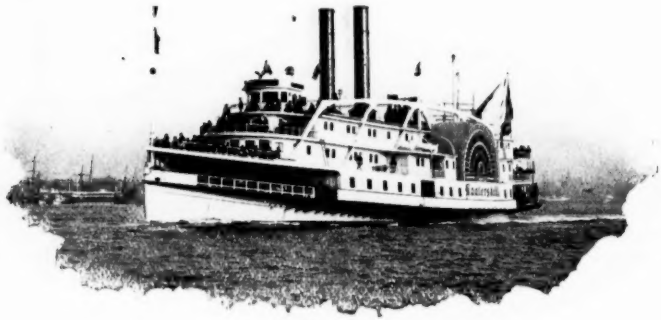
ALBANY.

become famous. Heretofore the saloons had been but single decks in height; now these vessels appeared with great saloons, with galleries around them, double tiers of staterooms, almost unlimited passenger accommodations, and conveniences unthought of. The New World, when finished, was twelve feet broader than before, and the Isaac Newton was sixty feet longer. The grand saloons of these boats were for many a day the great "show pieces" of interior steamboat architecture in this country. A feature was the lighting of the saloons with gas. The order of architecture on the Isaac Newton was Gothic, while that of the New World was Corinthian. The Francis Skiddy, of the New York and Troy line, also underwent similar changes, and became a great night boat.

In 1860 a new boat was added to the day line,—the Daniel Drew, which became widely known as the fastest boat then on the river. Her hull was a model of symmetry and grace. On October 13, 1860, she ran to Albany in seven hours and twenty minutes, or, deducting the



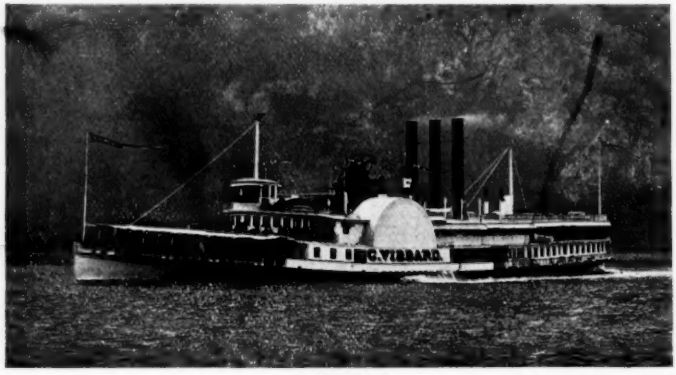
1 SWALLOW. 2 BALLOON. 3 FRANCIS SKIDDY. 4 ST. JOHN. 5 SARATOGA.



KAATERSKILL.

time lost at the five landings, six hours and fifty minutes,—thus maintaining an average speed of twenty-two miles an hour throughout the trip.

In 1861 a boat was placed on the Hudson that was destined to become the most popular river steamer ever in American waters. This was the world famous Mary Powell, "Queen of the Hudson," which made some of the quickest passages on record, being able to steam up to twenty-five miles an hour. In 1881 she made her fastest time between New York and Rondout, her regular route, leaving New York at 3:33 P. M., and arriving at Rondout at 7:45. The distance is ninety-two miles.



C. VIBBARD.

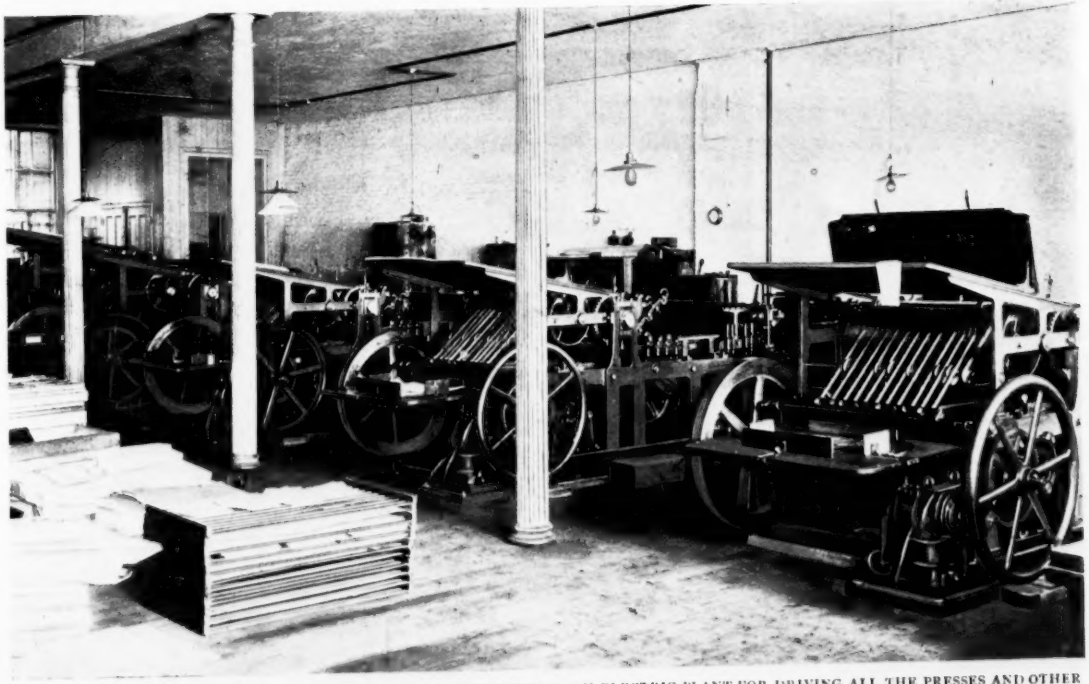
NEW YORK.

Three wonderful river boats were set afloat in 1863, 1865, and 1866. They were the St. John, Dean Richmond, and Drew, respectively, and they were built for the People's Line. The general plan of the rebuilt New World and Isaac Newton was followed in the new boats, only on a larger and finer scale.

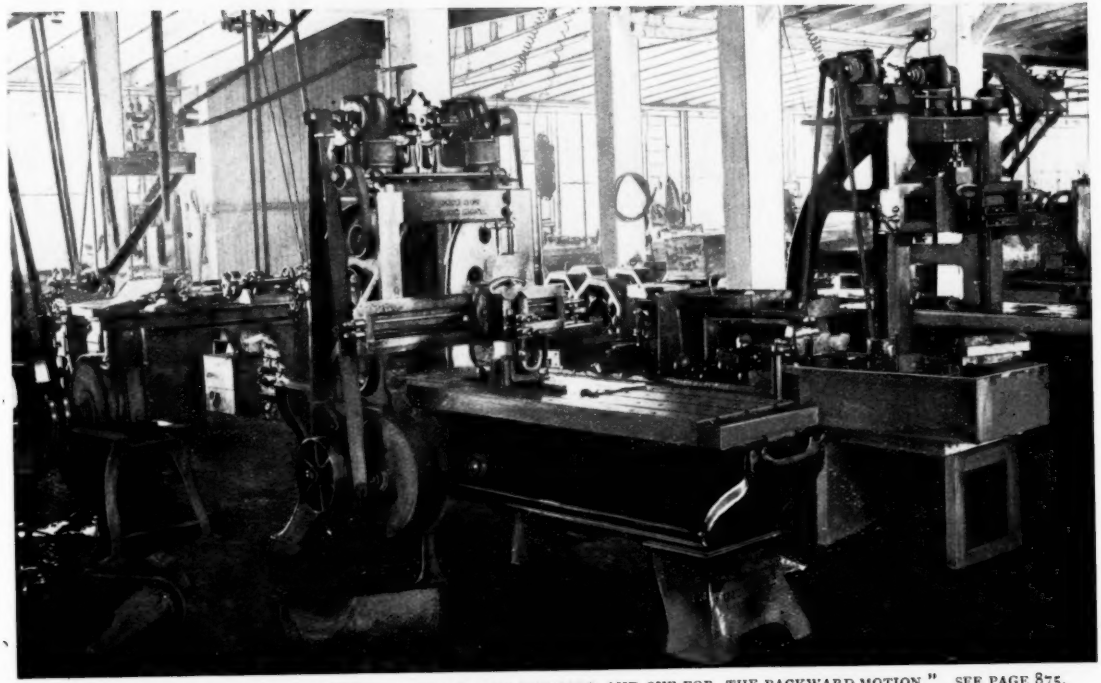
The most modern and elegant boats now running on the Hudson River are the New York and the Albany, two steam vessels which are the finest river passenger steamboats in the world. They are stanch craft, well arranged, and beautifully finished and furnished,—ideal American river steamers. Either is able to make twenty-four miles an hour. The general design is quite different from that of the old-time river steamer. There are no boilers on the guards, and many established rules that entered into the designing of the Hudson River steamboat of twenty years ago have been ignored in their construction. Yet they may be compared to the old class of steamboat as we compare our modern naval vessels to those of civil war times. There are those who can see little beauty in our new cruisers and battle-ships, but go into raptures over the appearance of one of Uncle Sam's old "wooden walls"; so there are steamboatmen and others who prefer the appearance of the Mary Powell to that of the Albany, or would rather gaze on the outlines of the Alida than on those of the elegant New York.

However the appearance of the boats has changed, the paddle-wheel and beam engine have held their own through all. A number of attempts have been made at times to introduce the propeller,—notably in the City of Kingston, on the Rondout line, and the Nupha, on the Catskill route,—but these boats soon gave way to side-wheelers.

On no other river in the world has such a succession of magnificent passenger boats been run as on the Hudson. Having their own distinctive type, and that the best adapted, in point of speed and comfort, for passenger travel, they have always held a high place in the maritime world.



"A PRINTING ESTABLISHMENT IN NEW YORK HAS RECENTLY PUT IN AN ELECTRIC PLANT FOR DRIVING ALL THE PRESSES AND OTHER MACHINERY." SEE PAGE 875.



"PLANERS DRIVEN EACH BY TWO MOTORS, ONE FOR THE FORWARD AND ONE FOR THE BACKWARD MOTION." SEE PAGE 875.

ELECTRIC POWER FOR ISOLATED FACTORIES.

By W. A. Anthony.

THE use of isolated lighting-plants in manufactories has been in vogue for several years both in country and city, and is now so common that hardly any manufactory of any pretensions is projected in which the lighting-plant does not form a part of the original plan. The great advantage in convenience and economy is so well recognized that it is unnecessary to dwell upon it. The advantages of using electricity for the transmission of power from the steam-engine or other prime mover to the work are, however, not so well understood, and this means of transmission is by no means so generally employed as its advantages warrant. That power can be transmitted by electricity is perfectly well understood; generators, motors, and conductors are at hand; what remains is to demonstrate the advantages over other modes of transmission,—to show that it will "*pay*."

It is not claimed that electrical transmission is in all cases superior to other modes. Each case must be considered by itself, the various conditions studied, and the advantages and disadvantages of the different possible means of obtaining the power at the point where it is to be used carefully weighed. If the problem is to deliver the power of a waterfall at a distant point, the question to be answered is a very simple one: Will the power delivered cost less than if delivered by other means, or than power generated on the spot? These costs are not difficult to determine in any particular case, and the question can easily be answered. There are numerous examples of such transmission, but the advantages are not always so great as they seem. The original cost, and cost of maintenance, of a water-power plant not infrequently render it anything but an inexpensive source of power; and, when there is added to this the element of variability and uncertainty that often exists, it is not uncommon that the advantages are in favor of the steam-engine on the premises.

The distribution of power by electricity from central stations to numerous small consumers has especial advantages, and is in extensive use. When consumers are scattered, there is no other method of distribution by which they can be so easily reached, and no other method by which they can be supplied with so little loss. Exactly in the same line is the electrical distribution of power from a central point to the scattered shops of a large manufactory. At first this took the form of motors driving lines of shafting, or, if machines were scattered,

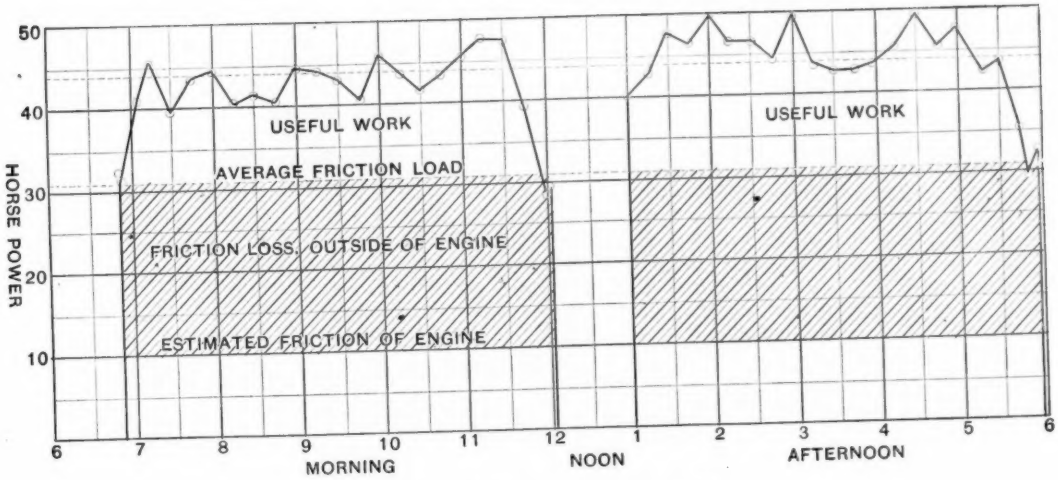


FIGURE I. "A TYPICAL LOAD DIAGRAM."

motors were in some cases used to drive individual machines, the advantage of the motor over a long line of shafting being apparent. But now the question arises: just how far can electrical distribution displace shafting? The answer can only be given for each special case, after studying all the conditions.

The following general considerations will assist in arriving at a solution:

The cost of shafting per unit of power transmitted is least when machinery is compactly grouped in close proximity to the source of power. In such case, furthermore, the proportion of power lost in this mode of transmission is least,—that is, the efficiency of transmission is highest.

The loss by friction of shafting and belting is constant whether the machinery it is intended to drive is in use or not; hence, when machines are not in constant use, the efficiency of transmission is lowered.

In an electric plant the cost of conductors is comparatively small, and widely-scattered machinery may be reached with only a small addition to the cost of the plant.

When individual motors are used for each machine, the motor stops with the machine, and with it the flow of current from the generator. Hence stopping a machine stops its proportion of the loss in transmission. It is the same as though the machine were driven from the engine-room by an independent line of shafting which stopped with the machine.

An electric motor consumes current nearly in proportion to the load; therefore, it may be used for light loads without excessive waste of power.

An incidental advantage in the use of individually-driven machines is the absence of conditions other than the requirements of the work, to control the location or alignment. A machine having its own motor mounted upon it may be placed where it is most convenient to the work it has to do, without regard to the position or direction of lines of shafting.

Another advantage is the absence of dust and dirt from running belts.

The waste power from the running of shafting and belting while some of the machines they are to drive are idle varies greatly, of course, in different plants. It will be least in manufactories of staple goods, where all parts of the plant are so proportioned and balanced that each machine must run continuously. It is greatest in repair and jobbing shops, and in manufactories doing custom work. In such plants a great variety of machines must be provided to meet the ex-

igencies that may arise, and many of these machines find only occasional use.

The waste power may be determined in any given case by measuring the power consumed at short intervals through the day. This may be done by means of a dynamometer, by taking indicator diagrams from the engine, or by any other suitable means. If a shaft is driven by an electric motor, a recording ammeter will give the best possible indication of the character of the load. The Crocker-Wheeler Electric Co. has made measurements of several plants for this very purpose, and by their permission I reproduce here [Figure 1] a typical load diagram. The broken line represents the indicated power at the engine cylinder at intervals of fifteen minutes through the day. The average load for the day is 44.1 horse-power. Of this 12.8 is useful load, and 31.3 is friction of engine and shafting. Ten horse-power is assumed as the friction of the engine, leaving 21.3 horse-power for shafting,—about 62.5 per cent. of the power delivered by the engine, and 166.4 per cent. of the useful load. If this power were electrically transmitted, the power lost in transmission should not be more than half the useful load, or 6.4 horse-power,—a saving of 14.9 horse-power. This power would cost in such a plant not less than $60 per horse-power per year, or $894. Assuming that an electric plant to replace the shafting would cost $2000, interest and depreciation would amount to $200,—a saving of $694 per year by the electric plant.

Figure 2 is a load diagram from one section of a large silk manufactory where the conditions are especially favorable to high efficiency in transmission by lines of shafting. The useful load is heavy and uniform, the increase after four o'clock being due to the turning on of electric lamps. The regular working-load is about 435 horse-power. The power indicated at 12-05 and 6-05—about 185 horse-power—is the friction load of engine and shafting. The useful load is, therefore, 250 horse-power. Estimating the friction of the engine at 50 horse-power, that of the shafting is 135 horse-power, and the efficiency of transmission is 65 per cent. A 400 horse-power direct coupled engine and electric generator, furnishing power to motors of 1 to 5 horse-power, should give an efficiency of transmission of 70 per cent., —a higher efficiency than shafting gives in this most favorable case. At this efficiency 357 horse-power delivered to the electric generator would give the 250 horse-power useful load; that is, the loss in transmission would be 107 in place of 135 horse-power. This saving of 28 horse-power is worth, at $40 per horse-power per annum, $1120. It is a question whether, in this most unfavorable case for electric transmission, the saving effected would not more than pay for the electric installation.

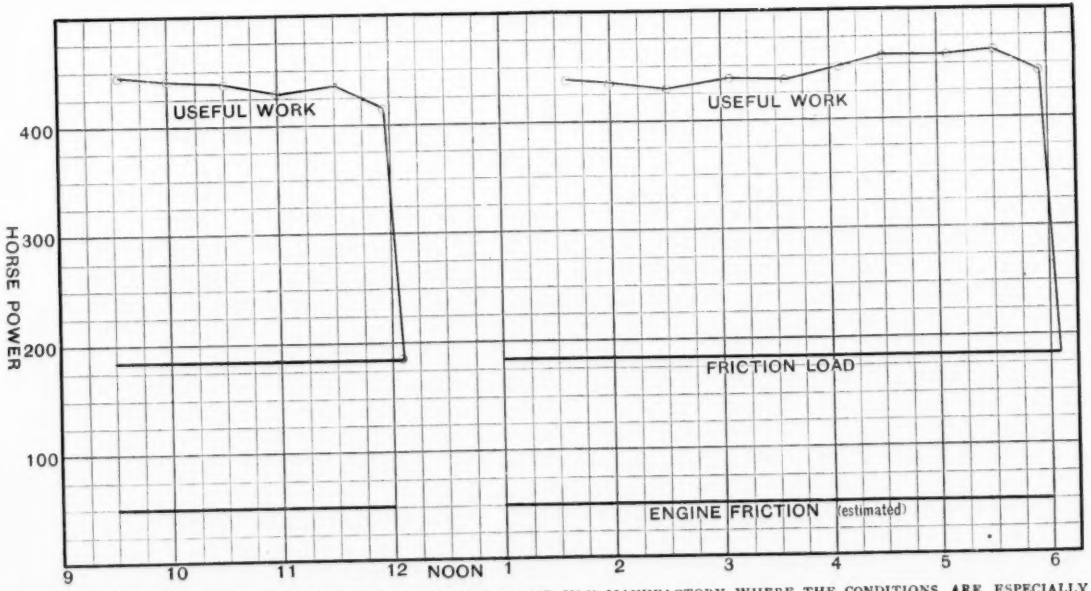


FIGURE 2. "A LOAD DIAGRAM FROM ONE SECTION OF A LARGE SILK MANUFACTORY WHERE THE CONDITIONS ARE ESPECIALLY FAVORABLE TO HIGH EFFICIENCY IN TRANSMISSION BY LINES OF SHAFTING."

It has been already stated that the first applications of the electric motor in manufactories was to drive machinery through lines of shafting. This was an obvious application, furnishing an easy means of reaching machinery in out-of-the-way places, or scattered buildings. The efficiency of transmission was not so much considered as convenience in reaching the machines to be driven. But it is evident that, in using shafting driven by electric motors, the losses of both systems of transmission are added, and it would seem that, if the full benefit of electric transmission is to be obtained, shafting must be entirely done away with, and a motor used to drive each machine.

This would be true, if large and small motors were all of the same efficiency; but, because of the higher efficiency of large motors, it may be of advantage in certain cases to group a number of small machines about one motor, using short lines of shafting for transmission from the motor to the machines.

A brief description of some typical plants will bring out more clearly the advantages of electrical transmission.

A large brewery in Milwaukee, whose buildings cover several blocks, has an electric power-generating plant at a central location, and the power is distributed electrically to the various buildings. The generating plant consists of a compound condensing engine driving two 120 kw. power generators, and a 60 kw. generator for lights. The motors are 50, 40, 30 horse-power, and smaller, twenty-three in all. In one case two 50 horse-power motors run in multiple upon the same shaft. In this plant the conditions were such that no other provision for power was possible, except the location of separate steam plants at the points where power was needed. The advantage in this case was the location at one point under one engineer of a generating plant of the first class, in place of small engines of lower efficiency at scattered locations, requiring several engineers. There was a saving of wages of engineers and firemen, a higher economy in the use of fuel, and the further advantage that the power at any point was always ready when wanted.

In a large plant at Greenpoint, Long Island, for building iron bridges, roofs, etc., electric transmission is used throughout. The machines consist of heavy punches, shears, bending machines, etc., which are used as the work in progress demands. In general, each machine is driven by an electric motor. In a few cases two or three machines are driven by one motor through a short line of shafting. One important incidental advantage of the use of electrical transmission in this case was apparent at first sight of the plant. The location of machines was made to suit the work. There was no shafting to control the alignment, and no belts were to be provided for. The

nature of the work to be done is such that the use of the tools must to a great extent be intermittent. Indeed, there were installed altogether 149 horse-power in motors, while the generator that furnishes the current, not only for the motors, but for the arc and incandescent lamps for the entire establishment, is only 75 horse-power. The tools in this plant cover a large area, and, although they are under one roof, shafting to reach them all would consume continuously more power than is consumed by all the tools usually running at any one time.

A printing establishment in New York has recently put in an electric plant for driving all the presses and other machinery. The illustration on page 867 gives a view of one side of the press room, showing a line of presses, each driven by a Crocker-Wheeler motor, geared directly to the driving shaft of the press. Another line of presses occupies the opposite side of the room, and other machinery driven by individual motors occupies other floors in the building. There is an entire absence of belting and shafting. Each press is handled entirely by its motor through the motor-starting box, which is placed where it is most convenient to the hand of the operator. Whenever a press stops, the transmission loss stops with it, and, as the machines of a printing establishment often have long periods of rest, the economy of electrical transmission is apparent. A 15 kw. generator supplies current not only for the motors, but for all the lights of the establishment.

Several of the methods of employing electric transmission are exemplified at the Crocker-Wheeler factories. Power is carried to scattered buildings, to short lines of shafting in the same room, to individual machines by belting to the machine from a motor suitably placed and by making the motor an integral part of the machine, to hoists and cranes, etc. The illustration on page 868 shows planers driven each by two motors, one for the forward and one for the backward motion.

In the use of motors for running drills, lathes, and other machines requiring to be run at different speeds, it is important to avoid changing the speed by means of resistances in the armature circuit, as the efficiency of the motor is then very low, and the high efficiency, which is one great advantage of electric transmission, is lost. Change of speed should be obtained by some mechanical device, or by such a construction of the motor as will permit variation of the speed by varying its counter electro-motive force.

It must be borne in mind also that one great advantage of electric over shafting transmission results from the stopping of the motor when the machine is idle. To secure this advantage the motor should be geared to the machine in such a way that the motor must be stopped

to stop the machine. If the connection is made by means of a clutch, or fast and loose pulley, which the operator ordinarily uses for stops of short duration, it will be found that the motor will be allowed to run, and much of the possible advantage lost. Even where load is most uniform and machines in most constant use, the idle time will not be less than five to ten per cent., and if motors are stopped during that time, it will effect a saving of that percentage in the transmission load.

Many machines, especially machine tools, hoists, blowers, etc., have been built in which the electric motor forms part of the original design, and this construction will find wider and wider applications as the advantages of electrical transmission come to be better understood. In many cases, as in the printing presses illustrated in the cut, no essential change of design is needed to enable the motor to be geared directly to the machine.

The electrical-transmission plants described or referred to in this article have been given only as typical examples. Many other examples might have been adduced, in some cases comprising a thousand horse-power or more in a single plant. Almost every variety of manufactory may advantageously employ electric transmission. The Crocker-Wheeler Co. are arranging to attach motors to silk looms for a silk manufactory now in process of erection. One advantage to be gained in this case is cleanliness.

As already stated, the advantages of electric transmission will vary greatly under different conditions. The cost of an electric installation will, perhaps, in most cases exceed that of shafting and pulleys, but in so many cases does the saving of power more than warrant the additional outlay that it would be a mistake in any new project not to have made a careful estimate of the relative advantages of electric compared with other modes of transmission. It is not to be expected that the advantages to be derived will in many cases warrant the discarding of machinery and lines of shafting forming the equipment of established manufactories; but, in the case of new projects, where everything may be planned from the beginning with reference to electric transmission, every advantage of this method may be secured. Machines can be located to suit the work; where necessary, the entire space overhead may be kept clear of all obstructions, even of wires; the lighting of the establishment can be provided for off the same system; machines in out-of-the-way places may be supplied with power,—in short, the system offers many advantages besides higher efficiency, and no disadvantage except a greater first cost.

THE CONSTRUCTION OF A GREAT BUILDING.

By Francis H. Kimball.

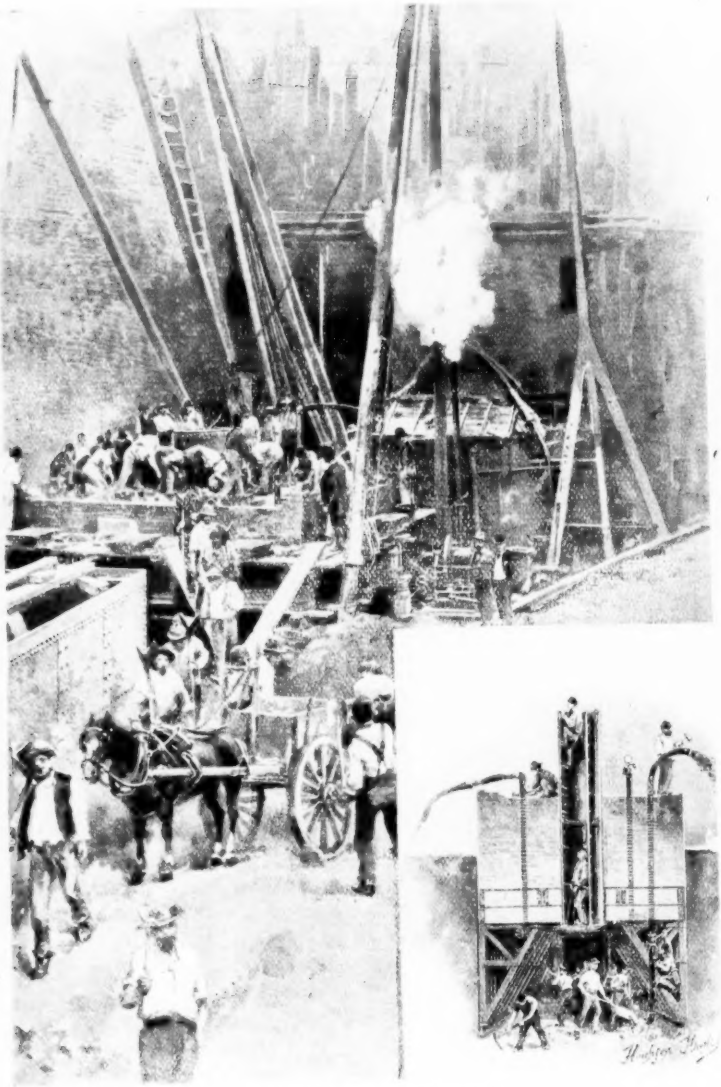
IT is but a few years since it was considered among the wonderful accomplishments of the time to erect and equip an office-building of ten stories in height in a period of twelve months, starting on the first day of May to remove the existing building, and in the following May turning over to the owner the finished production. Something more is expected of the architect and builder of the present day. In place of ten stories, twenty are now considered only a fair year's work, providing the conditions and season are favorable.

Is it because we are any better equipped in appliances or machinery that we can double the production of former days, and are our mechanics more skilled in the use of tools and quicker in their movements? Or is it due to a gradual development, year by year, of improved methods in handling men and material?

Examples of quick building of the present time point undoubtedly to a great extent to the latter theory, although new methods of construction have been introduced within the last ten years tending to greater facility in the erection of the structural parts. We have the same master and the same mechanic with us to-day, who, without any more apparent exertion, will put up a twenty-story building in the same time it took them ten years ago to put up ten stories. At the same rate of progress, we shall expect them ten years hence to put up a thirty-story building in the same time.

All of this depends largely of course on the difficulties encountered, among the greatest of which is that of securing a proper foundation for such a gigantic structure. Another—and one which builders fear most—is labor troubles, from which none of the large buildings thus far erected has been free, and to which much of the delay is due. But, given a fair start, by which is meant ample preparation for the architect in working up his plans, and good builders in accord with the architect in all his views, there seems to be no apparent reason why the limit of a year's work need be twenty stories.

The stability of such a structure, the materials entering into which are piled up and put together so rapidly, is a matter of serious consideration. We may be leaving to our successors a troublesome inheritance; not that we are working close to the danger limit in our calculations of strength, but that we are trying to force out of much of the material used more than its character seems to warrant, the

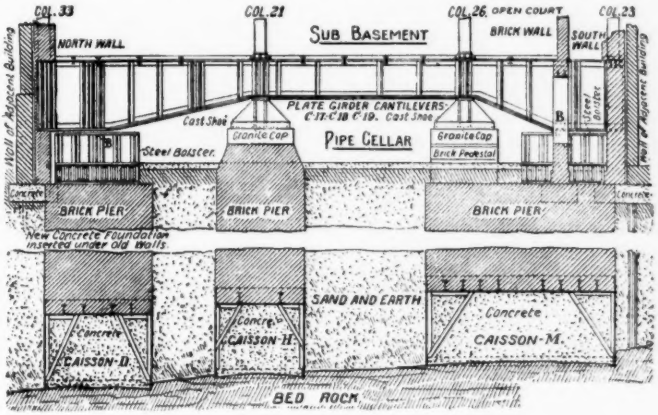


PREPARING THE FOUNDATION.

consequence of which will be constant repairs in the future, involving in the aggregate a cost exceeding the saving realized in the quicker returns on the investment at the beginning.

But architects know all this, and so does the investor in a great measure: yet the temptation to excel some other record in the quick-building line, together with a desire for quick returns from rentals, losing but one season, is more than the investor can withstand. The architect has no choice in the matter: he must accept the inevitable, and bring to bear all his skill to accomplish the end desired in the best and most workmanlike manner.

It is not difficult, at the close of one of these quick-building operations, to trace the reasons which led to so successful a termination

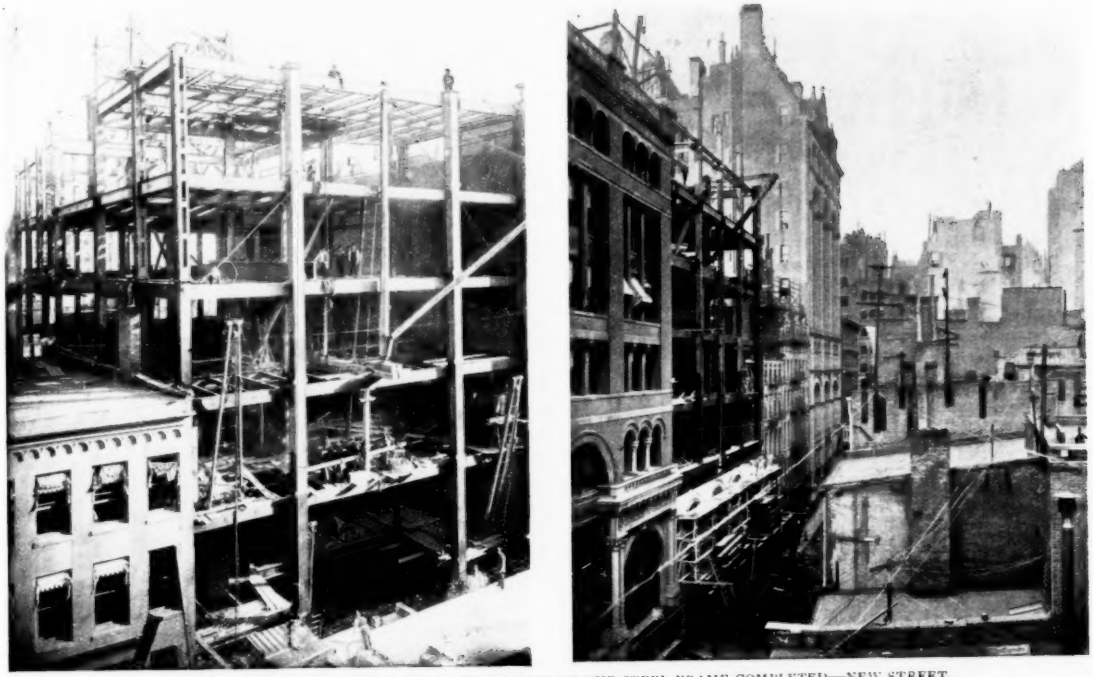


PLAN SHOWING FOUNDATION OF BUILDING.

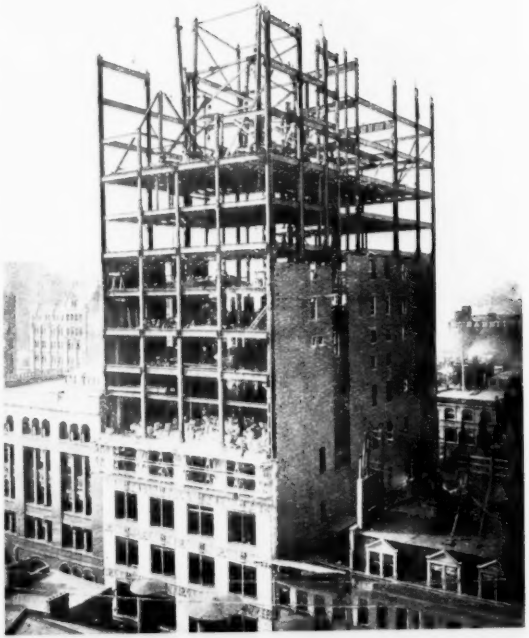
The most recent example, in point of the actual time consumed in erection and in finishing the great bulk of the building,—which has not been equalled up to the present time, pound for pound of iron and brick for brick of masonry,—is the Manhattan Life Insurance Building, with which the writer is identified.

No comparison can be made between New York and Chicago records, as our building laws are much more rigid, in that they exact a greater degree of stability in the structural features.

In the case of the Manhattan Life Building, the time consumed in its erection may be divided into two parts, as follows: foundations ready for super-structure, five and two-thirds months: super-structure, eight months. The roof, or eighteenth tier of beams, was reached in exactly three months from the time when the foundations were ready.



BROADWAY—OCTOBER 17TH, FIRST SIX STORIES OF THE STEEL FRAME COMPLETED—NEW STREET.



BROADWAY—NOVEMBER 18TH, STEEL FRAME COMPLETED TO 14TH AND STONE WORK TO 5TH STORY—NEW STREET.

on which to set the first piece of steel composing the bolsters that support the cantilever system.

The time spent in preparing the foundations may seem, to those unfamiliar with this work, scarcely consistent with the progress afterward made, but the architects found that, in view of the unsatisfactory nature of the ground, composed largely of quicksand, the usual methods employed, such as piling or masonry, were inadequate for the purpose of a foundation to sustain the great concentrated loads; and they thereupon decided to reach bed rock, fifty-seven feet below Broadway, by some unprecedented means. They finally concluded to introduce the pneumatic process used in sinking bridge piers to rock, an illustration of which process, as used under the Manhattan Life Building, is herewith given.

Sinking the piers to bed-rock rendered the building independent of any outside operations,—either building foundations or tunnels. The fact that they were the pioneers in this undertaking, so far as the application of this principle to building work is concerned, led to much carefulness on the part of the engineers, Messrs. Sooysmith & Co., in respect to the probable effect on the foundations of adjacent buildings; and that there might be no disturbance of such foundations, by reason of going so far below them, no attempt was made to force this work to the degree attained in bridge work where operations are carried on in an open country.

The magnitude of the work may be better understood by reducing it to cubic yards of masonry. This sub-structure, which starts on bed-rock and continues up to the level of the cellar floor, consists of fifteen piers, varying in size from 9′ 0″ in diameter to 21′ 6″ × 25′ 0″ square. The caissons made of steel corresponded in size to the piers they sustain, and were eleven feet in height. These caissons were filled with concrete, and contained altogether 1260 cubic yards. The number of bricks used in the piers amounted to 1,500,000.

From this it may be seen that a good sized building was sunk out of sight before any part of the super-structure could be begun.

The fact that a new method, with more or less experimental work attending its adoption, had to be devised, and the really large mass of masonry forming the piers, are sufficient excuses for the length of time consumed in this feature of the building. It was a work which in olden times might have taken twelve months. Even the progress attained was due to the fact that three relays, or gangs of men, were employed in sinking the caissons, thus giving the work the benefit of the full twenty-four hours in one day, for the entire period of five and two-thirds months, except in the case of the masons, who worked only during regular hours.

The super-structure, when once started, proceeded rapidly, the rates of progress from month to month being shown by the views herewith given. What is not apparent in the views is the complicated nature of the construction, due to the form of the open court, the special framing to meet the arrangements of the Company's quarters on the sixth floor, the great height and weight of the tower, and provision for wind-bracing, in consequence of which all the stories could not be erected with the same degree of rapidity.

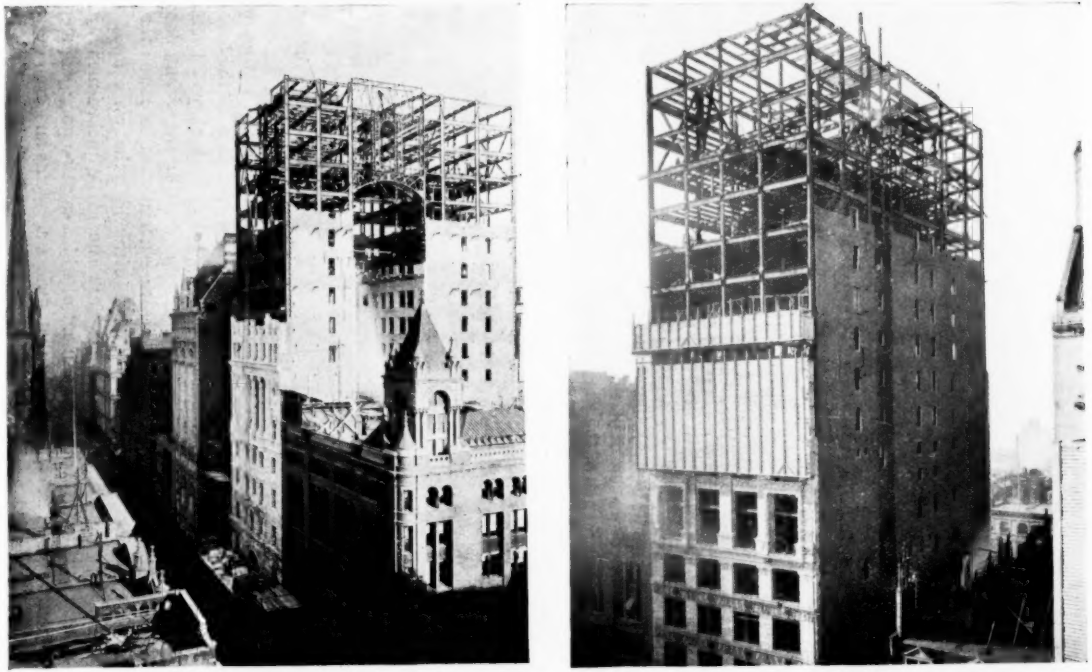
Suffice it to say that in three months about 5800 tons of steel were raised into position. This was not accomplished, however, without night work. When the foundation work was prolonged to September 1, the prospect of completing the building on May 1 was not promising. A council was held,—attended by the building committee, architects, and builders,—the purpose of which was to incite the builders to greater activity, and also to settle upon a plan for beginning and continuing night work until the roof was reached.

This meeting resulted in the institution of day and night gangs of men for the erection of the steel frame: and by reason of the time which, in consequence of the delay in the foundations, the contractors for this branch of the work obtained for the making of the wrought material and the delivering of the same within a short haul of the building, coupled with the fact that great care was taken at the rolling mills in laying out the various members to templates so that, when they were assembled at the building, no fitting was required, the work of erection went on without interruption from the beginning to the end. Recalling the incidents of these three months' work, and the system employed to produce the quickest results, it seems that no mistakes were made and that every moment was counted.

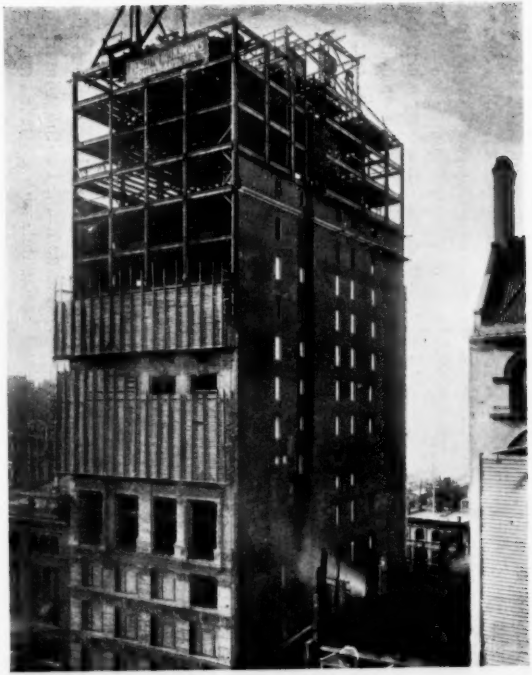
To better illustrate the magnitude of the skeleton, I may say that there were girders weighing forty tons, many columns of ten and twelve tons each, and cantilevers of eighty tons (in four sections of twenty tons each), the length being sixty-seven feet.

All of these heavy members required special means of transportation: the heaviest girder had to be rolled from the dock to the building by night, the task requiring three nights. It took just twenty minutes to raise it from the street to its position on the second floor.

On account of the great risks where material must be raised three hundred feet in the air, and the haste with which the work must be done, the setters of iron and stone work should be picked men with certain qualities, the most prominent of which must be good judgment and steady nerves. It is rarely that serious accidents and even deaths are not recorded against buildings of even less magnitude than the Manhattan Life Building, but, strange to say, in this case there was



BROADWAY—DECEMBER 8TH, STEEL FRAME COMPLETED AND STONE WORK UP TO THE 9TH STORY—NEW STREET.



BROADWAY—DECEMBER 27TH, STEEL TOWER BEGUN AND STONE WORK UP TO THE 13TH STORY—NEW STREET.

no loss of life, and but few accidents worth mentioning. The work was greatly facilitated by the use of a traveling frame, with a derrick at each angle, by which material could be easily disposed of as it was raised from the street, and placed in its proper position.

It was considered advisable to begin the brick masonry when four stories of the steel frame had been set in position. This enabled the frame-setters to keep in advance of the other trades. As far as possible, this plan was pursued throughout; but, inasmuch as bad weather has no effect on iron and steel, while with masonry the contrary is the case, at times it was necessary to lay off the masons while the others pursued their work. When high winds prevailed, all work had to cease. But with good weather, when all could work advantageously, the masons could hardly hold their own.

There seemed to be a friendly rivalry between the two trades as to which should outstrip the other; and the greater the exertion the brighter was the prospect of closing in the building before cold weather set in.

Rough piping, both for plumbing and steam, began when the masons had reached the fourth story, and continued without interruption until all the lines, vertical and horizontal, with all their branches, were in position. In the meantime the masons had begun setting the fire-proof blocks forming the partitions, and as far as practicable this was carried along with the advancement of the outside walls.

When the partitions of a story had been set, the electrician ran his wires, enclosed in conduits, to the various fixture outlets. One can hardly realize now that this "roughing," as it is called by the workmen, is concealed from view,—that more than five and one-half miles of gas, water, waste, and vent pipes, five miles of steam pipes, and thirty-five miles of electric wires, were required to perfect the respective systems. The facing of the front on Broadway contains about thirty thousand cubic feet of stone, which was cut and set in position in eighty days.

It was not at first the idea to undertake to finish more than ten stories by the first day of May, as the plastering could not be commenced until the winter was well advanced, and the outlook for enclosing the roof seemed distant and discouraging. When the twelfth story was reached, a temporary roof was deemed necessary for the protection from rain and snow of all the stories below; and such roof was constructed, and was of great help in removing all fear of damage to the finer grades of interior fittings.

Immediately thereafter plastering was begun, temporary heat was supplied, windows enclosed, and a general advancement made towards the completion of the stories below. There was no cessation, how-

ever, in building above this temporary roof. Fortunately the weather was propitious, causing but little delay. The building was permanently enclosed by the time severe weather set in. Then all the forces that could be brought to bear were employed in the supreme effort of getting the entire building in such condition that tenants could occupy on the first of May any rooms that they might choose. It was successful. It proved a good investment for the company, as the greater proportion of the offices rented were above the sixth story.

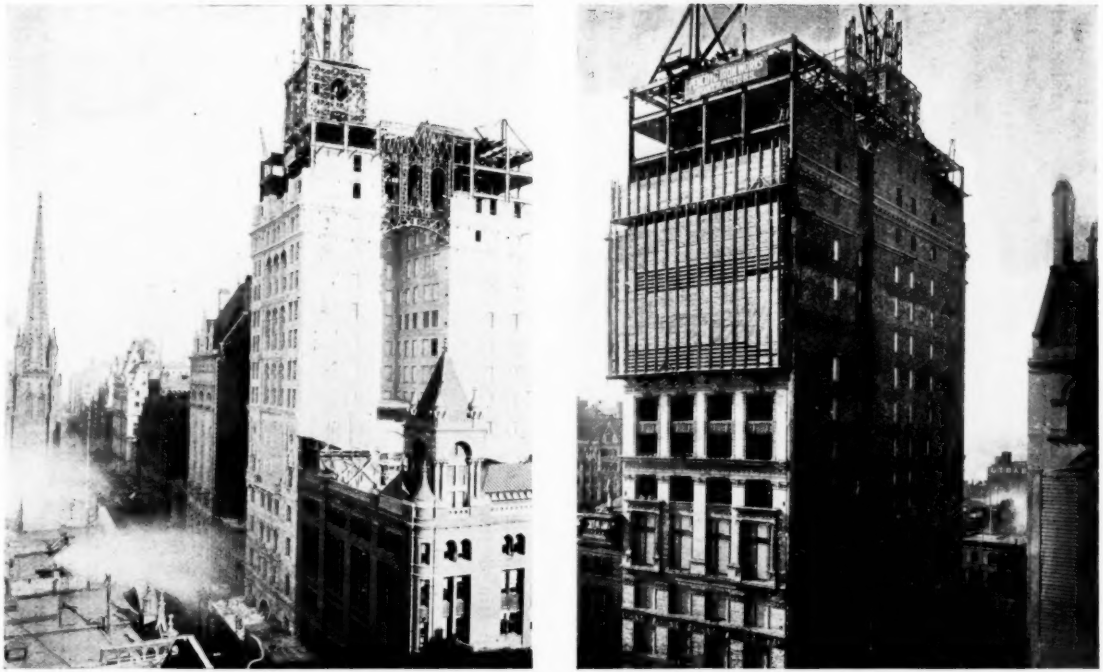
To follow all the different trades, and describe the various methods employed to force the work almost beyond the limit of human endurance, would be an interesting story. Suffice it to say that to the layman there can be no realization of the vastness of the undertaking.

Take the laying-out of the engineer's department,—the boiler and engine, the electric and elevator plants, the plumbing and heating systems contained in a building of this magnitude, the decorative treatment of the interior, employing the carpenter and cabinet-maker, plasterer, marble-worker, and metal-worker (on stairs and elevator fronts), the mosaic and tile flooring, gas and electric fixtures for lighting, to say nothing of a more or less ornamental exterior,—and it seems hardly less than a miracle that all these different interests, all large because the building is large, could have worked harmoniously together, and achieved such satisfactory results in the period of eight months.

It might be asked: have manufacturers of building material kept up with the rapid advance in methods of handling, producing articles that will set more quickly, and reducing to the minimum the danger of destruction, such as that from dampness proceeding from brick, plastering, and concreting?

If the "drying-out" of a building could be reduced to a few weeks, instead of months, the length of time required for its erection would not be so much a matter of uncertainty. Some thought has been given to the mixing and manufacture of plaster, the application of which is made more simple than formerly by certain quick-setting qualities which make it practicable to put on the wood trimming within a few days after a room is white-coated.

There is yet room for improvement in the direction of freeing the process of plastering from dampness, and rendering it less objectionable, from the standpoint of cleanliness, to those who must follow the plasterers. But there is one feature of the mason's work to which much attention has been paid during the past ten years, but seemingly not in the right direction; for the difficulty remains, although the material is harder. I refer to fireproof blocking used for partitions and flat arches between beams. The blocks designed for partitions are not of uniform size: therefore the surface of one side of the partition



BROADWAY—JANUARY 12TH, FIFTH STORY OF TOWER COMPLETED AND STONE WORK UP TO THE 16TH STORY—NEW STREET.

BROADWAY—MARCH 2D, STONE WORK COMPLETED, BUILDING ROOFED, AND TOWER READY FOR ENCLOSURE—NEW STREET.

becomes very irregular, as the mason lays up one side to a line. The plasterer must even up with plaster, the thickness of which varies anywhere from half an inch to one and one-half inches. It cannot be expected that the shrinkage of plaster will be uniform,—to say nothing of the danger of freezing when the work is done in the winter months. Fireproofing of floors between beams consists usually of flat arches formed of terra-cotta blocks made hollow to secure lightness. These blocks do not make up a thickness equal to the depth of the beam, where the beam is more than 8 inches. They vary in depth according to the span between beams; and, where the beam is more than 8 inches, there is a space above the arch to be filled, in order to meet the material of which the finished floor is composed. This space may be 4 inches, possibly 6 inches,—sometimes more, sometimes less, according to the depth of beam. The concrete is generally composed of ashes and cement, especially when saving in weight is important.

Such a foundation is not of the substance required where there is a direct action thereon,—as in the case of tile or mosaic floors,—proceeding from the heavy and constant traffic usual in business buildings. Consequently such floors show the natural impact of the spongy concrete by numerous cracks, which, in the case of mosaic floors, can never be properly repaired.

This defect is not the only one of importance. A large percentage of the dampness usual in mason-work proceeds from this source. As this concreting is usually done just before the laying of the floors, it is quickly covered in, and dampness must pass through the wood-flooring in the process of drying-out. It is natural to suppose that kiln-dried lumber will absorb much of the dampness, and swell in consequence, so that afterward, when heat is turned on, it will shrink and open at every joint. More thought should be paid to a remedy for this, which may properly be termed a defect. Arches could be made that would reduce the space referred to, thus removing an element which, although it may not materially retard quick building, causes much of the criticism on the defective work (so considered) now credited to rapid methods of building. Other features no doubt enter into this class of building to which attention might be directed with profit to the builder, but it is hardly possible to discuss them in detail here. The individual experiences of others would be interesting and valuable.

Without coöperation on the part of the builder, the architect's suggestions are of no advantage, and the work lags in consequence. It is important, therefore, that none but the most reliable men should be selected to do the work. The architect, moreover, should make the selection, for, if he is to come in for his share of censure in case of delay, it is better that he and his own men should wholly deserve it,

THE MANHATTAN LIFE INSURANCE BUILDING.

than that he should suffer for mistakes over which he has had no control. Should the whole work pass into the control of one firm (usually masons), it should be an arrangement satisfactory to the architects.

The architects of the Manhattan Life Building, Messrs. Kimball & Thompson, were ably assisted throughout, and they take great pleasure in publicly acknowledging their indebtedness to the different firms who aided them to make so remarkable a record. Messrs. Sooysmith & Co., engineers, did all the work in connection with the foundations and caissons. A. & P. Roberts & Co., the Pencoyd Iron Works of Philadelphia, finished and erected all the iron and steel construction, as well as the ornamental interior iron and exterior copper work. They sublet to Richey, Browne & Donald of Brooklyn all the stairs and elevator fronts, and other ornamental iron work, and to James White, also of Brooklyn, the copper work. All other contracts were assumed by Richard Deeves & Son, who sub-let the carpenter and cabinet-work to the Geo. C. Flint Co.; the marble, mosaic, and tile work to Traitel Bros. & Co., who in turn sub-let the marble portion to H. C. & G. S. Bailie; steam-heating to Gillis & Geoghegan; elevators to Otis Bros. & Co.; plumbing to J. N. Knight & Son; plastering to J. J. Roberts, for whom H. Berger's Sons did the ornamental plaster decorations; electric work to the N. Y. Electric Equipment Co.; boilers (of which there are three of the marine type, 10 feet in diameter) to the Quintard Iron Works, N. F. Palmer & Co. The elaborate bronze screens on the sixth floor, the Company's offices, were made by Richey, Browne & Donald; the color decorations and stained glass, by Arnold & Locke of Brooklyn; and the brass work around the engines and dynamos, by H. W. Steinert. All of these men took a personal interest in devising means to further the work, providing a sufficiency of men and materials at the proper times.

In the preparation of the drawings for the constructional steel and iron work, the architects called to their aid the services of Mr. C. O. Brown, engineer, who made all the extensive calculations and prepared the necessary drawings issued to the Pencoyd Iron Works.

Without an active building committee it is possible for an architect to fail, even though well-equipped in other respects. Prompt consideration of important matters arising from time to time is of valuable assistance to the architect. Such a committee the architects of the Manhattan Life Building were fortunate in having.

Finally: the secret of success always lies in constant, unremitting push in every department. Begin at the very beginning; an ounce of push at the start is worth a pound of push at the end. Start the trades whenever and wherever it is possible so to do, and keep up the tension; then satisfactory results cannot fail to follow.

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J A C S..Jour. Am. Chem. So. *m.* $5. Easton.
J A E S..Jour. Assoc. Eng. Soc. *m.* $3. Chicago.
J A N E..Jour. Am. Soc. Naval Engineers. *qr.* $5. Washington.
J F I.....Jour. Franklin Institute. *m* $5. Phila.
J G L....Journal of Gas Lighting. *w.* London.
J M W A.Jour. of United Metal Workers of America. *w.* $1. N. Y.
J N E W.Jour. N. E Waterw. As. *q.* $2. New London.
J P E.....Jour. Polit. Economy. *q.* $3. Chicago.
J S A....Journal of the So. of Arts. *w.* London.
L A.....The Landscape Architect. *m.* $1.50. Rochester.
L E.....Locomotive Engineering. *m.* $2. N. Y.
L. H. P..Light, Heat and Power. *m.* $3. Phila.
M.....Machinery. *m.* 9*s.* London.
M A.. ..Machinery. *m.* 50 cts. N. Y.
M & B...Manufacturer and Builder. *m.* $1.50. N. Y.
M E.....Marine Engineer. *m.* 7*s.* 6*d.* London.
Met W...Metal Worker. *w.* $2. N. Y.
Mill.....Milling. *m.* $2. Chicago.
Min. R...The Mining Review. *w.* $2. Denver.
M I T....Mining Industry. *w.* $3. Denver.
Min W..The Mining World. *w.* 21*s.* London.
M J.....The Mining Jour. *w.* £1. 8*s.* London.
Mo ...The Monist. *qr.* $2. Chicago.
M R ....Manufacturer's Record. *w.* $4. Baltimore.
M S P....Min. and Sci. Press. *w.* $3. San Francisco.
M W.....Mechanical World. *w.* 8*s.* 8*d.* London.
N..... Nature. *w.* $7. London.
N A R...North American Review. *m.* $5. N. Y.
N B .....National Builder. *m.* $3. Chicago.
N C.....Nineteenth Century. *m.* $4.50 London.
N C B...National Car Builder. *m.* $2. New York.
N S R....The New Science Review. *qr.* $2. N. Y.
N W.....Nowest. Architect. *m.* $3. Minneapolis.
P.....Paving. & Mun. Eng. *m.* $2. Indianapolis.
P A.....Progressive Age. *s-m.* $3. New York.
P E C P. Procd. Engineer's Club. *q.* $2. Phila.
P Eng....Practical Engineer. *w.* 10*s.* London.
Pl D.....Plumber and Decor. *m.* 6*s.* 6*d.* London.
Pr.....Power. *m.* $1. N. Y.
P S M....Popular Science Monthly. *m.* $5. N. Y.
R A.....Railway Age. *w.* $4. Chicago.
R C J....Railroad Car Journal. *m.* $1. New York.
R E M....Railway Engineering and Mechanics. *m.* $1. Chicago.
R G .....Railroad Gazette. *w.* $4.20. N. Y.
R of R...Review of Reviews. *m.* $2.50. New York.
R P L....The Railway Press. *m.* 7*s.* London.
R R.....Railway Review. *w.* $2. Chicago.
R W.....Railway World. *m.* 5*s.* London.
Ry T.. ..The Railway Times. £1. 5*s.* London.
S... .....Stone. *m.* $2. Chicago.
S A.....Southern Architect. *m.* $2. Atlanta.
San.....Sanitarian. *m.* $4. Brooklyn.
Sc A.....Scientific American. *w.* $3. New York.
Sc A S...Scientific Am. Supplement. *w.* $5. N. Y.
Sc M....Scribner's Magazine. *m.* $3. New York.
Sc Q.....Scientific Quarterly. *q.* $2. Golden, Col
S E.....Stationary Engineer. *m.* $1. Chicago.
S Ec ....Social Economist. *m.* $1.50, N. Y.
Sea.....Seaboard. *w.* $2. New York.
S In.....Stevens' Indicator. *qr.* $1.50. Hoboken.
S J E....Sibley Jour. of Eng. *m.* $2. Ithaca, N. Y.
S L.....Steamship. *m* Leith, Scotland.
S M.....Scientific Machinist. *s-m.* $1.50. Cleveland, O.
S M Q....School of Mines Quarterly. $2. N. Y.
S R.....Sanitary Record. *m.* 10*s.* London.
S R E N..St. R'y. Elec. News. *m.* $2. Minneapolis.
S P.....Sanitary Plumber. *s-m.* $2. New York.
S R G....Street Railway Gazette. *w.* $3. Chicago.
S R J....Street Railway Journal. *m.* $4. New York.
S R R.. .Street Railway Review. *m.* $2. Chicago.
S V.....Safety Valve. *m.* $1. New York.
T... ....Tradesman. *s-m.* $2. Chattanooga, Tenn.
T A I E E.Trans. Am. Ins. Elec. Eng. *m.* $5. N. Y.
T C E....Trans. Am. Soc. Civil Eng. *m.* $10. N. Y.
T Q.....Technology Quarterly. $3. Boston.
Tr.....Transport. *w.* £1. 5*s.* London.
Tr A M E.Trans. Am. Ins. of Mining Eng. N. Y.
T W A .Trans. of the Wis. Acad. Madison.
W A....Western America. *m.* $1. Omaha.
W E.....Western Electrician. *w.* $3. Chicago.
W R.....Westminster Review. *m.* $4.50. London

ARCHITECTURE & BUILDING

Sky-Scrapers.

THIS facetious and somewhat satirical term has been popularly applied to the tall buildings that are fast becoming the most conspicuous—certainly not the most graceful—feature of modern urban architeture. Taking it as a title, Mr. F.C. Gordon in *The American Architect* (Dec. 8) alleges that this class of structure has come to stay. No amount of protest will avail against it. The large rentals such buildings return to their owners for a stated ground rent, as compared with lower buildings on the same-priced lots, appeal so strongly to the money-getting spirit of the age that these buildings find increasing favor. If one were to seek for the best architectural exemplifications of this spirit and of the rule of supreme selfishness in the present age, he would find them in the tall office-buildings and the tenement-houses. In point of intrinsic beauty these two classes of buildings are about on a par. Let us be candid, however, and admit that tall buildings serve well as office-buildings, and that the favor with which they are regarded by tenants is at least one valid reason for their existence.

In Mr. Gordon's view "the one utilitarian objection to very lofty buildings is that they will cut off the daylight from the streets below. It is true, it would be very undesirable to build them on both sides of a narrow street. But we have the public squares and parks surrounded by business streets, which would look all the more noble if built up twenty stories to a depth of sixty feet; then dropping down to fifteen stories for forty feet, and after that letting the limit of height be twelve, ten, eight, or six stories, according to the width of the streets. If all the public squares of New York were lined with twenty-story buildings, much more than the whole office community would be accommodated better than now, and, even from a distance (down the harbor, for instance), the profile would give a very imposing effect.

"The esthetic objection is that they are ugly and cannot be made beautiful. It would indeed be most regrettable if our cities were doomed to be filled with structures more ugly than those they already contain. But let us first inquire whether any really honest and earnest effort has yet been made to give consistent beauty to the 'sky-scraper.' How were the Greek temple and Gothic cathedral made beautiful? Chiefly by making them true, and by permitting the style to evolve itself naturally from the needs and conditions under which they were built. The first artist-builders of those noble structures used all the skill, knowledge, and fine sense of the beautiful of which they were possessed to make them delightful to the eye and monuments of man's genius for all time. But beauty alone was not the first or fundamental thought. Use and construction came first, ornament afterward, and the style was the inevitable outcome of the method of construction and the material used."

If the spirit of the time that has given birth to the tall office-building is to be embodied in its architecture, where is the opportunity for art? The amassing of more wealth by concentration of the power which wealth gives, and by its direction to that purpose alone, is already well expressed in the tall office-building, which goes on its way skyward regardless of aught but this single object. But, aside from artistic considerations, the practical results in the near future regarding street traffic deserve some attention. Mr. Gordon has evolved a scheme for proportioning the height of tall buildings to width of streets; but a difficulty arises. Neither the spirit of the age nor the uses to which such buildings are put will admit of such adjustment.

"First, the office-building is entirely and purely a place of business. There is room there for nothing else. *Utility* is, therefore, its first requirement. There must be all possible floor-space; abundance of di-

rect light (not less than two-fifths of the outside wall-space should consist of windows); perfect provision for artificial light, heating, and ventilation; roomy corridors illuminated by direct light; and ample elevator-service, stairways, and fire-escapes. It must be fitted with all the conveniences that modern life insists on and has made possible; in short, it must have everything and be everything to enable every move of business to be a 'rapid transit.'"

It is to be all for business. Business dispatch and utility are the ruling motives. Such being the case, the tendency must inevitably be to localize these buildings, and cluster them around and near certain points, regardless of symmetry, regardless of anything but the money-getting they are intended to facilitate. This tendency to localization in business is too apparent to be lost sight of by even a superficial observer. In any large commercial town there will be a dry-goods district, a financial center, etc., each prominent business grouping around some favored spot, rarely a park or a square; and this is governed not by fancy or caprice, but by a law of trade. To get custom one must go where customers most congregate.

If a new city were to be built with a view to encourage tall buildings, with streets four or five times as wide as they are now, the tall building would not be so objectionable as it is, either in point of appearance or in its other features. It used to be thought in most large modern cities that the streets were inconveniently crowded; but tall buildings erected on narrow streets, attracting four or five times as many people as formerly, have rendered some streets at certain hours of the day well-nigh impassable. Had not facilities for street traffic in some measure kept pace with the increased crowding, some streets would have been hopelessly blocked before this time. With streets now appropriated by trolley- and cable-railway lines, the outlook for much increase in facilities for street traffic is not encouraging. But high building is still going on with great vigor, and twenty-story structures are not merely talked of,—they are planned and are going up. Is it not worth while to bestow some attention upon the condition of traffic on narrow streets that will surely come in the near future?

The Reliance Building, Chicago.

THE lofty office-buildings which are going up in the large cities of the United States are attracting attention abroad, and naturally enough—the engineering problems worked out in their construction being their most interesting feature—this attention is manifested in publications devoted to engineering rather than architecture. Thus *Engineering* (London, Nov. 2) gave an illustrated description of the Reliance Building, Chicago.

This is truly a tall building, being fourteen stories, or 200 feet in height. Its breadth is only 55 feet, and this disproportion gives the building the appearance of a tower rising above the common level of the five-story buildings surrounding it. The reasons for the selection of this building as a type of tall structures in the United States are not very apparent, as it certainly is not among the best existing examples, and in external appearance it is not admirable. Probably the selection was influenced by the circumstances of its construction, which may seem somewhat extraordinary from an English point of view, but which have had numerous precedents on this side of the Atlantic.

Briefly, this is the history of its erection. The building was originally a five-story, very strongly built structure, the lower story being occupied as a bank, and the superstructure rented to various tenants. It was decided that, when the leases of these tenants expired (May 1, 1894), the building should be altered into one of sixteen stories.

The foundations and first story were taken out in 1890, and rebuilt according to the plans for the contemplated tall building, the superstructure being supported on screws while this work was in progress. Meanwhile the original plans for a sixteen-story building were modified, and it was decided to make it only fourteen-story. In the spring of the present year the three upper stories were taken down, and the building was continued from the second

story, the tenants of the second story remaining in it while the building was being completed.

The exterior of the building is of white enameled terra cotta and plate glass, which, together with its great height and disproportionate width, renders it conspicuous enough, if that was the motive of its designer. The modest four-story building with attic and dormer windows that flanks it on the left is a much more agreeable object to look at.

Some features of the construction exemplify the extent to which engineering enters into the construction of modern buildings.

"For wind bracing, instead of tension rods, which have been used heretofore, it was determined to put plate girders 24 inches deep at each door between the outside columns, thus binding the columns together, and transferring the wind strain from story to story on the table-leg principle. These plate girders are bolted to the face of the column, and form a perfectly rigid connection with the column. The columns are in two-story lengths, and adjoining columns break the joints at each floor. Every piece of iron in the construction, including all the roof beams, is thoroughly fireproofed with porous fireproofing. Each piece of fire-proofing around the column is wired to the column with copper wire."

"The Z-bar column, with its horizontal cap-plates breaking the column in two at every story, was discarded in this building, and a new column used, composed of eight angles. The cast-iron columns so dear to our British architects have been abandoned in all good work in the States, and have led to the design of many different types of columns built from rolled sections of steel. Special attention is paid to the question of making easy connections between the girders and these columns, and for most purposes standard connections are used,—a plan which favors cheapness of construction. A favorite type of column for office-buildings has been the Z-bar column mentioned above. The column which has replaced this form in the new building is the design of Mr. Gray, and consists of a number of angles riveted together. A large number of tests on full-sized specimens have been made at the Keystone Bridge Works with perfectly satisfactory results, and from these it has been found that for all sizes of columns the safe load can be taken to be $(17{,}100-57\frac{l}{r})$ lb. per square inch, where l is the length and r the radius of gyration of the column, the ends of which are taken as fixed. The ends of this column were planed off and connected by means of vertical splice-plates."

It is claimed that the interior finish of this building, when completed, will be finer than that of any building yet erected in Chicago, which is claiming a great deal, as those who are familiar with the finer Chicago buildings will agree. The woodwork will be of mahogany, the floors of marble mosaic, the halls on first and second floors finished with colored, and those on other floors with white, Italian marble.

What is known as the "Durham" system of plumbing will be used in this building,—a system in which "risers, wastes, vents, and down-spouts are of wrought iron coated inside and out while hot with coal-tar varnish" and put together with screw joints.

The heating will be by steam from boilers in the cellar. What is known to the heating trade as the one-pipe system will be used. The steam for heating ascends to the top of the building through an 8-inch riser pipe. Thence it is led off through branches to distributing riser pipes, which lead down to the cellar again, and which not only convey steam to the radiator connections, but also carry down the water of condensation to a return system in the basement. The 8-inch riser rests on a pier at the bottom, and its expansion is altogether upward. The distributing risers have expansion joints, and are run under the fire-proofing material of the columns.

Evolution of American Architecture.

Architecture and Building (Nov. 24) contains a paper by Mr. J. W. Yost, read before the 28th annual convention of the American Institute of Architects, held last October. The subject is dealt with in a clearer manner than is usual with writers

who let themselves loose on "styles," particularly when speculating upon the genesis of styles. Much that has been said upon this subject is such unintelligible gibberish as to prompt the thought that its authors did not themselves know what they were talking about, and that they were in search of something in architecture about as clearly perceived by them as would be the idea of the fourth dimension by a youth whose preliminary preparation for the conception of this idea has been ordinary school instruction in the first book of Euclidean geometry.

A good impression is produced by the avowed and deliberate exclusion of the words "order" and "style" from the title of the paper; yet, notwithstanding, these intrusive words will slip into the discussion, as though the wholesome resolution formed had not enough strength to bar them out. The point of the argument is that a truly American Architecture will ultimately be evolved "under the law of natural selection, by survival of the fittest," and that this law ("which has governed the production of every variety of architecture throughout history") will assuredly give to America, in the fullness of time, an architecture whose "character, when compared with that of all historic work, will be as broad as our own civilization is broad when compared with the civilization of historic times." Out of present heterogeneity is to emerge a characteristic unity and harmony, or rather (to use the definition of life given by a learned writer on psychology) "unity in multeity."

"No nation has heretofore existed possessing the multiplicity of wants we have. No people ever before possessed the personal freedom of taste and the ability to provide an expression for it that we have. No style of architecture has ever been produced under such a variety of climatic influences as this country affords. Never have the designers and the builders of any country had at their control such a varied supply of building materials and building appliances. Never have people of any age or clime possessed such a complete knowledge of what all previous periods have done, or had at their command such ready means of full communication with each other and everybody else. Probably no nation of people was ever made up of so great a variety of races, nationalities, and antecedent conditions as exists with us."

The progress of evolution out of this confused mass of tendencies, each of which will exert an influence, is outlined with much imaginative power.

"In the evolution of a national architecture under the law of natural selection by the survival of the fittest, and under the conditions prevailing in this country, we begin by the use of first one style, then another, and then another, always terminating the experiment by softening the lines of demarcation between them, just as the settlement of the country began, first with a colony from another, and then from another. All these colonies mingle, and soon the special characteristics of each begin to disappear. Then comes another colony and mingles with the others, the new immigrants having less and less influence upon the whole civilization in proportion as that which has come under the new environment becomes greater and greater in proportion to what comes from abroad, until by and by the volume of American civilization will be so vast in proportion to the importation of foreign influences that the importation will cease to be in any appreciable measure a disturbing element. The peculiarities of all the races and nationalities will merge into a newly evolved human entity known as American. If architecture be true to its principles as a delineator of ethnographic life, it must follow this same process of accretion, assimilation, of elimination and crystallization, until out of the architectural styles of all the world there will come, in its own good time, an expression composed of all, yet different from all, governed by new requirements and limitations; and it will be known as 'American architecture.'"

But this is not to be in our day. A century at least will be required to produce a marked and specific differentiation from existing and preëxisting types. In

the meantime we have to learn "how to design, what to design, and what may be used for ornament," with the understanding that the search for answers to questions thus raised must reach beyond "the plane of the merely necessary," and extend to the beautification of the useful. Thus the esthetic side is evidently the one from which the predicted evolution of American architecture is expected to make its most characteristic advance.

Architects as Promoters.

IN a paper recently read before the Minnesota Chapter of the American Institute of Architects, Mr. Walter S. Pardee discussed the propriety of the promotion of building enterprises by architects. This question seems to be about on a level with that of the propriety of an active interest in politics on the part of the clergymen, and should find its proper answer in conscience and good taste. It is discussed from the standpoints of honor and profit,—honor on the architect's side and profit on both sides. "If it will not dishonor the profession for an architect to promote a building enterprise; if it appears that it will be a profitable enterprise for the client; if there is enough in it to pay the architect for his time and thought; or if the client means to go ahead with the enterprise after having been informed by the architect of the real *nature of the scheme,—then we say, yes.* It is proper for an architect to promote a building enterprise."

Of the forms which promotion by an architect may take, the commonest is, perhaps, "when an architect details to a prosperous friend the delights inherent in a beautiful home, and suggests that this friend permit the architect to make such sketches in perspective, and such outlines in plan, as will awake in the friend and the members of his family a strong desire to be possessed of such a home." Another example is "when an architect asks the man of means, who owns a fine business corner, to consider if it would be a good location for a business block or hotel." Again, an architect may take "a third party into his confidence, whose duty it is to see the prospective client, and recommend that the interested architect be employed to do the work." A more effective form of promoting is "when the architect, having passed the first stages of progress, proceeds to interest his influential friends; lay plans for convincing the client or clients, either by his own efforts or those of his friends,—thus laying out a plan of work that he hopes will have the desired effect." A reprehensible mode of promotion, which we hope is rare, though Mr. Pardee thinks it far too common, is when the architect "maligns his rival, or by other dishonorable means proceeds to gain his point."

In general: "Judging from present practice and indications, an architect's promotion of a building enterprise is one of those special ways to obtain work that each man would like a monopoly of, but that should be free to all. Broadly considered and honorably conducted, it is probable that such a thing would be advantageous to the profession. It ought to aid in stamping out some of the evils that threaten us."

The Third Highest Tower and the Loftiest Statue in the World.

AN illustrated description of the tower of the new City Hall, Philadelphia, in the *Scientific American* (Dec. 15), gives particulars of this remarkable structure, and also of the lofty statue of William Penn, which is its crowning feature. The statue stands on a pedestal at the upper extremity of the tower, five hundred and two feet from the ground. It is "thirty-seven feet high, and weighs sixty thousand pounds. The sculptor who designed it is Mr. Alexander Calder. The statue is said to embody" the popular conception of Penn's character. In face and pose the figure is strong, though there is about it all a Quakerly air of gentleness and simplicity. He wears the Quaker garb of the seventeenth century, with long straight coat and loose knee-breeches.

"A full-sized figure was first modeled in plaster by Mr. Calder at the City Hall. This was then separated into fourteen horizontal sections and removed to the Tacony Iron Works, at Tacony, Pa., where the figure was to be cast. The castings were made direct from the fourteen sec-

tions, thus preventing any variation from the original design. The statue was cast in aluminum bronze, the walls of the statue averaging five-eighths of an inch in thickness. This work was accomplished without mishap, and no parts needed to be recast. The sections are provided with inside flanges three inches wide, and are pierced with one-inch bolt-holes. The bolts are also made of aluminum bronze, to guard against the galvanic action which would occur between bronze and a more electropositive metal.

"After the castings had received the finishing touches at the foundry, the sections were assembled in the court-yard of the City Hall and set up temporarily. The statue stood in this position for more than a year, and has been examined by many thousands of curious spectators. The principal dimensions are as follows:

"Height, thirty-seven feet; hat-rim, twenty-three feet in circumference; nose, thirteen inches long; hair, four feet long; shoulders, twenty-eight feet in circumference; waist, nine feet in diameter; legs, from ankle to knee, ten feet; feet, five feet four inches long."

The statue was hoisted in sections, first to a staging at a height of three hundred and fifty feet, and thence to the pedestal on which it stands. The picture of it in the *Scientific American* shows it on the pedestal temporarily erected in the City Hall, with a group of men at its foot. The cut strongly reminds one of the pictures of Gulliver and the Liliputians in "Gulliver's Travels." Another picture shows it on the tower, and the fastening is described as "a number of three-inch bolts passing through the base of the figure and the plate forming the cap of the dome," though exactly what is meant by the "base of the figure" is not definitely explained.

The "Cairo Building," Washington.

UNDER the title "An Architectural and Engineering Triumph," the *Inventive Age* gives an illustrated description of this building, the design of which shows that in the modern tall-building idea the beautiful or picturesque somehow still refuses to be embodied. The building is of the steel skeleton variety, 100x122 feet on the ground, and thirteen stories high. The architecture is said to be of the "Egyptian order," because there are a few features in it resembling what may be found in ancient Egyptian building, but this attempt to combine the very ancient with the very modern has produced an extremely incongruous—not to say absurd—result. The architect is also the owner of the building, and his "remarkable activity and artistic architectural skill" are said to have won him fame, though he is yet a young man.

"The Cairo is located on Q street, between Sixteenth and Seventeenth streets, and commands a beautiful view of the city with its environments. The front, for the first four stories, is composed of Indiana limestones; the upper portion a combination of the latter with buff brick, the whole finished off with an ornamental iron cornice projecting five feet beyond the plumb-line. In the center a square projection, forty feet in width, breaks at the fifth floor into two octagonal bays. These are connected at several stories by elaborately carved balconies upheld by delicate stone columns. At each front corner a square, tower-like projection runs the entire height of the big building. At the fourth and tenth stories there are balconies supported by huge griffin-like figures. At the eighth floor additional balconies extend from the corner towers to, and are connected with, the central bays. The principal entrance, reached by a broad flight of steps, is through a wide recessed archway," the arch being semicircular.

Balconies and a semicircular arch on a building of the "Egyptian order of architecture" seem about as incongruous as Egyptian hieroglyphs would be on a Roman temple. The picture of the building shows that the Egyptian features are confined to the "ornamental" (?) iron cornice and the first stories of the "tower-like projections," these projections being broader at the foundation than at the third story; and the iron-foundry is suggested by the cornice much more than the ancient architecture of Cairo, after which city the building is named. Doubtless the

interior, which is intended to be used partly as a sort of family hotel, or boarding-house, and partly for apartment housekeeping, may be commodious and well adapted to these purposes; but the exterior is not "a thing of beauty," and no amount of ill-judged and indiscriminate praise can make it such.

THE German Emperor has rendered himself obnoxious to the artists in Germany by his treatment of Wallot, the architect of the new Parliament House at Berlin. The *American Architect* (January 12th) says that while decorations and honors were bestowed upon clerks, contractors and foremen connected with the work, the architect was intentionally ignored, and that when he was selected by the Berlin Academy of Fine Arts as the recipient of one of its great gold medals, the Emperor struck his name off from the list of nominations and substituted that of a lady whose contributions had been rejected by the Academy. Subsequently, while in Rome, the Emperor spoke very slightingly of Herr Wallot's design. The united architectural societies of Germany vented their displeasure at the Emperor's treatment of a great architect by giving a Wallot banquet.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*26712. The Reliance Building, Chicago. Ill. (E-Nov. 2.) 2700 w.

27037. Evolution of American Architecture. J. W. Yost (A & B-Nov. 24.) 4500 w.

*27459. The Construction of a Great Building.—Progressive Stages of the Work. Ill. Francis H. Kimball (E Mag-Feb.) 3000 w.

27464. A New Building Bill for London. E. A. E. Woodrow (A A-Dec. 8.) 2400 w.

27465. The "Sky-Scraper." F. C. Gordon (A A-Dec. 8.) 2500 w.

27503. Underpinning the Schermerhorn Building Walls. Ill. (E R-Dec. 8.) 700 w.

*27511. Marble in Gothic Buildings (I C B-Nov. 30.) 1600 w.

*27514. The Gothic Revival (I C B-Nov. 30.) 4200 w.

*27515. The Pointed Arch in the East (I C B-Nov. 30.) 900 w.

*27516. Gothic Arches. Ill. (I C B-Nov. 30.) 1600 w.

*27517. The Pointed Arch. Ill. A. S. J. (I C B-Nov. 30.) 600 w.

*27518. The Young Architect (I C B-Nov. 30.) 800 w.

*27555. Metallic Construction in America (A L-Nov. 30.) 1800 w.

*27581. Tewkesbury Abbey. Ill. (B-Dec. 1.) 2200 w.

*27616. Architectural Practice in Relation to Promoted Building Interests. Walter S. Pardee (A B D-Nov.) 1600 w.

27617. Cast and Wrought Iron for Frame Work of Buildings (Sc A-Dec. 15.) 1200 w.

27618. The Tower of the New City Hall, Philadelphia, Pa.—The Loftiest Statue in the World. Ill. (Sc A-Dec. 15.) 1200 w.

27623. One of the Latest High Buildings.—American Tract Society Building. Ill. (R G-Dec. 14.) 1500 w.

27662. An Architectural Engineering Triumph.—The "Cairo," Washington. Ill. (I Age-Dec.) 1100 w.

*27676. Commercialism in Art. Ill. (B-Dec. 8.) 4500 w.

27679. A New Fireproof Construction. Ill. H. B. Seely (A A-Dec. 15.) 2000 w.

*27692. Sliding Roof for Theatres. Ill. (E E L-Dec. 7.) 900 w.

27707. Red Lead Paint for Iron. Ralph K. Wing (A & B-Dec. 15.) 900 w.

*27750. Trans-Atlantic Notes. Ill. Arthur Lee (S-Dec.) 1500 w.

*27752. The New Union Station at St. Louis. Ill. (S-Dec.) 2000 w.

*27761. The Victoria Hall of Geneva. Ill. Lawrence Harvey (A L-Dec. 7.) 1600 w.

*27762. Training of Architects. (Abstract.) Arthur Hill (A L-Dec. 7.) 900 w.

*27763. The New Boy-Architect. (Abstract.) Frank Caws (A L-Dec. 7.) 1500 w.

*27768. Acoustics in Buildings (I C B-Dec. 7.) 800 w.

*27772. Rural Architecture (I C B-Dec. 7.) 1700 w.

*27773. Slates and Slating (I C B-Dec. 7.) 400 w.

†27784. The Passing of Gothic Art. Conrad Bryant Schaefer (I A-Dec.) 2800 w.

27814. The Society of the New York Hospital and Its New House of Relief. Ill. (Sc A-Dec. 22.) 1300 w.

27815. The Manhattan Life Building. Ill. (Sc A-Dec. 22.) 1800 w.

27821. The Calculation of Hip and Valley Angles in Roof Work. Ill. C. A. P. Turner (E N-Dec. 20.) 1500 w.

27823. Wind Bracing in High Buildings. (Abstract.) Guy B. Waite (E N-Dec. 20.) 1600 w.

We supply copies of these articles. See introductory.

27867. Traveling Scholarships.—What Work Must Be Done by the Student. R. W. Gibson (A & B-Dec. 22.) 1900 w.

27913. Specification for Structural Steel Work. C. H. Blackall (A A-Dec. 22.) 3200 w.

27915. The Horses of Apollo. Ill. (A A-Dec. 22.) 1400 w.

*27923. Country Homes. Ill. T. Raffles Davison (B A-Dec. 14.) 3600 w.

*27934. Some Suggestions as to Theatre Architecture. Editorial (B-Dec. 15.) 3300 w.

*27949. Some Historic Landmarks of London. Ill. John Gennings (Ch-Jan.) 4500 w.

*27953. Modern Mosaics. Ill. Isabella De Barbieri (A R-Jan.-March) 1800 w.

*27955. A White Enameled Building. Ill. Charles E. Jenkins (A R-Jan.-March) 1800 w.

*27956. The Historical Monuments of France. Russell Sturgis (A R-Jan.-March.) 2500 w.

*27957. A History of Old Colonial Architecture. Ill. Montgomery Schuyler (A R-Jan.-March.) 15000 w.

*27982. Sancta Sophia. Review of a book by W. R. Lethaby and Harold Swainson (A L-Dec. 14.) 3000 w.

*27984. Metal Ceilings Artistically Treated (N B-Dec. 22.) 1000 w.

*27986. The Practice and Province of the Architect (Can A-Dec.) 1800 w.

28013. Tests of a Fireproof Material for Floors in a Modern Building. Ill. J. Hollis Wells (E R-Dec. 22.) 1300 w.

28014. Fowler's Specifications for Roofs and Iron Buildings (E R-Dec. 22.) 1200 w.

28041. American Tract Societies' 20-Story Office Building, New York City. Ill. (E N-Dec. 27.) 2500 w.

28043. High Buildings of Steel Skeleton Construction (E N-Dec. 27.) 3000 w.

*28063. Siamese Sacred Architecture (B-Dec. 22.) 2800 w.

*28064. A Roman Villa at Darenth Kent (B-Dec. 22.) 2000 w.

*28143. New Developments (From Building News.) (I C B-Dec. 21.) 1800 w.

*28147. Windows. Ill. Anon. (I C B-Dec. 20.) 1600 w.

*28148. Mosaics of Our National Cathedral. Anon. (I C B-Dec. 21.) 2000 w.

*28150. Days in Rome. A. D. (I C B-Dec. 21.) 1300 w.

28173. Brooklyn's Memorial Arch. Ill. (Sc A-Jan. 5.) 450 w.

28198. The Cathedrals of France. Ill. Barr Ferree (Cos-Jan.) 4000 w.

28252. A Tile Roof for an Electric Lighting Plant. Ill. (R G-Jan. 4.) 600 w.

28258. The McKaig Bill (A & B-Jan. 5.) 2800 w.

28268. A Syrian Temple Ruin. Ill. Charles A. Rich (A A-Jan. 5.) 4500 w.

28289. Decorative Iron Work.—The Product of the American Artist-Blacksmith. Ill. W. H. Eckman (I T R-Jan. 3.) 1500 w.

*28336. The Competitive Designs for the Paris Exhibition of 1900 (B-Dec. 29.) 4500 w.

*28337. Some Curious Features of Old Parish Churches (B-Dec. 29.) 3000 w.

*28342. Handrailing—I. A Simple System. Ill. W. Twiss. II. A Spiral Stair. Ill. III. Handrailing Simple and Complex. Ill. W. Twiss. IV. Handrailing. Ill. Ungula. V. The Tangent System. Nulli Secundus (I C B-Dec 28.) 5800 w.

*28348. Arabesques and Grotesques (A L-Dec. 28. 2000 w.

Serials.

2285. Construction. Ill. M. Viollet-le-Duc (A A-Began Feb. 1892—Ended Dec. 29, 1894—29 parts—15 cts. each).

12568. Building Construction and Superintendence. Ill. F. E. Kidder (A & B-Began May 6, 1893—38 parts to date—15 cts. each).

19078. Problems in Stone-Cutting. Ill. Ed. W. Hind (S-Began Jan. 1894—10 parts to date—30 cts. each).

19713. Brick and Marble in the Middle Ages. Ill. (B B-Began Jan. 1894—12 parts to date—30 cts. each).

20419. Modern Methods of House Painting. A. Ashmun Kelly (Ph D-Began March—10 parts to date—30 cts. each).

21288. Theatres. Ill. (A A-Began April 14—9 parts to date—15 cts. each).

21736. The Art of Building Among the Romans. Ill. Auguste Choisy. Translated by Arthur J. Dillon (B B-Began April—8 parts to date—30 cts. each).

26070. The Planning and Construction of American Theatres. Ill. William H. Birkmire (A & B-Began Oct. 13—4 parts to date—15 cts. each).

26967. Stained Glass and Fret Lead Windows, etc. Ill. W. J. Eden Crane (I C B-Began Nov. 9—3 parts to date—30 cts. each).

27036. The Basilica and Its Adaptation to Modern City Churches. Ill. George Ashdown Audsley (A & B-Began Nov. 24—2 parts to date—15 cts. each).

27369. Foundations in and Unreliable Soils. J. Nelson (I C B-Began Nov. 23—Ended Nov. 30—2 parts—30 cts. each).

27924. The Modern Theatre of the Continent. Edwin O. Sachs (B A-Began Dec. 14—3 parts to date—30 cts. each).

27952. Christian Altars and Their Accessories. Ill. Caryl Coleman (A R-Began Jan.-March—1 part to date—30 cts).

27954. The Musical Ideals of Architecture. H. Toler Booraem (A R-Began Jan.-March—1 part to date—30 cts).

27983. Architectural Books. Herbert Batsford (A L-Began Dec. 14—Ended Dec. 21—2 parts—30 cts. each).

28018. Concretes, Cements and Mortars: Old and New. Fred T. Hodgson (B B-Began Dec.—1 part to date—30 cts).

28082. An Iron Residence Roof.—House of J. J. Astor. Ill. (E R-Began Dec. 29—1 part to date—15 cts).

We supply copies of these articles. See introductory.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal Engineering."

The Deep-Waterways Raid on the Public Treasury.

THE *Railway Age* (Dec. 7) editorially considers the present widespread effort to further deep-waterways projects as "a public danger." As evidence of the extraordinary number of these schemes now projected, the following list, brought before the Trans-Mississippi Congress at St. Louis in November, is presented. That all these schemes were favored is shown by the "resolutions adopted without debate," as indicated.

"(1) Asking that the Illinois and Mississippi canal, known as the 'Hennepin,' receive a sufficient appropriation annually from congress to speedily finish the work. (2) Favoring liberal appropriations for deep-water improvements on the Texas coast, and also (3) appropriations to ascertain to what extent the rivers of Texas can be made navigable. Asking congress to provide (4) for the construction of a deep-water harbor at San Pedro, Cal., and favoring the improvement of (5) Oakland harbor, (6) Sacramento, (7) San Joaquin river, and (8) Islay creek. (9) Favoring the continuous appropriation of money for the continuance of present improvements in the upper Mississippi river, and such new ones as shall be needed, including dredging and jetties so far as practicable. (10) Favoring the construction of a deep-water channel of not less than twenty-one feet in depth, to connect the great lakes with the Atlantic ocean by the way of the St. Lawrence; (11) also by way of the Hudson river; and the construction of canals (12) connecting Lake Superior with the Mississippi river, and (13) Lake Erie with the Ohio river. (14) Favoring the appropriation of sufficient money to increase the depth of water in the harbor of Duluth to twenty feet. (15) Favoring legislative action in behalf of the prompt construction of the Nicaragua canal under control and supervision of the United States."

It is computed that to carry out all these schemes would cost about $750,000,000, "yet the list is far from complete." This is a very large sum. The basis of estimate is not stated, and therefore a verification is not possible; but it would be less surprising to find that the estimate falls below, than to find that it exceeds, what all these improvements would actually cost. Is the country prepared to accept this great burden? Probably the promoters of any of these schemes realize that all of them cannot be carried out; but each hopes that his particular one will come to the top when the budget is sifted out, and safety for any one lies only in the ostensible approval of all. In this way the singular unanimity with which the whole batch of projects was favored in the convention can be explained.

"Seriously, the growing demand upon the public treasury, from every section of the country, for the construction of ship-canals and of deep waterways where nature failed to locate them have become appalling in their magnitude, and threaten to load all taxpayers with heavy burdens for the benefit of limited sections and favored localities. Before the day of railways, the waterways were the necessary routes of commerce, and national appropriations for their improvement and increase were defensible. Now, when hundreds of steam-roads, built by private capital, parallel and cross all the rivers and girdle every lake, furnishing cheap and rapid transportation for every locality, no matter what its natural situation, there is no need or excuse for taxing the western farmer, the miner in the mountains, and the sheep-raiser on the riverless plains to build ship-canals and reconstruct rivers alongside of the steel highways which are already more than sufficient to carry all the internal commerce of the country."

Prof. Cohn of Göttingen, in the *Economic Journal* (London), is quoted to illustrate the current expense of maintain-

ing deep waterways after they have been put in operation, and as sounding a note of warning. "The German waterways during the ten years 1881-90 cost the German government on an average 26,000,000 marks per annum against a revenue by tolls of 2,000,000. To this must be added interest on borrowed capital, etc., etc. This, at a yearly rate of 18,300,000, brings the former figure up to an annual expenditure (for Prussia only) of 36,700,000, against 2,000,000 of receipts. Thus nearly the entire surplus of the railway administration is swallowed up by the waterways. Traffic by inland navigation has so developed itself of recent years in Germany as to benefit more especially the larger firms, and that these should obtain gifts at public expense is a most perverted form of communism, since it compels the great mass of taxpayers to make sacrifices in the interest of the wealthy minority."

Prof. Adolph Wagner is also on record against what he styles the "*inverted communism* which calls upon the community, and especially districts which possess no waterways, and portions of the community which do not make use of them, to pay the vast cost of the waterways for the benefit of certain districts, places, and classes which do use them."

In France, also, there is a growing feeling of opposition to the injustice of the canal-building policy, which has been voiced in the *Journal des Débats* and other organs of public opinion. "At present the State is giving, so to speak, a bounty to those ports which it has furnished at public expense with inland water connection, and so turning aside to their profit a traffic which, but for that, would certainly fall to their rivals, who, as it is, bear the same burdens without enjoying the same advantages. The inequality is absolutely startling. The State is throwing its weight in on one side of a commercial struggle. There is but one possible solution,—the re establishment of tolls on inland waterways. Yet in this country the Erie canal, paralleled by numerous railways, is maintained by the State free of toll, and the national government is building canals and canalizing rivers at prodigious cost to be used free of charge by all who wish to engage in the business of carrying. It is indeed time that the attention of legislators and taxpayers in the United States were called to the abuse of governmental power which is encouraged and demanded by every waterways convention."

Cable-Haulage on Canals.

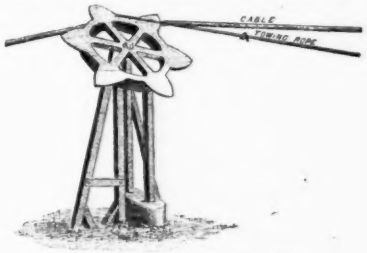
THE many attempts that have been made to render continuous haulage practicable on canals and the uniform failure that has attended previous efforts in this direction render the renewal of the effort, in France, all the more remarkable. It is, perhaps, the ingenuity of the device used as a solution of the problem that is most notable in the new method. An article in *The Engineer* (London, Dec. 7) describes and illustrates this device.

"The difficulty of preventing the escape of the cable from the pulleys offered plenty of scope for the ingenuity of engineers, and some of the most likely contrivances failed to act properly when put into practice. As events have since proved, this drawback would have been easily remedied if the cable could be made to run in a perfectly straight line; but in most installations there is scarcely a hundred yards of cable in which the direction has not to be changed by pulleys. The inequalities in the ground, the locks, the tunnels, and the curves in the canal necessitate a great many pulleys of various shapes and sizes, and these at first offered a serious impediment to the passage of the tow-rope attached to the cable. MM. Rigoni and Oriolle employed in their installations ordinary pulleys with smooth grooves, from which the cable was pulled away by the oblique strain of the boat. When at length this was overcome, a still greater difficulty presented itself in the awkwardness of turning corners by means of the cable. In the horizontal pulleys changing the direction of the cable away from the canal, and the vertical pulleys carrying the cable either over or under, the towing rope can pass easily without obstruction; but in many cases the cable

takes an inward direction, with the result that it has to pass around the outer edge of the pulley. It was evident, therefore, that the horizontal pulley carrying the cable away from the canal would have to be suppressed, and some other system devised whereby the towing rope would continue to follow the cable without interruption. This difficulty has been overcome by M. Maurice Levy, inspector-general of *ponts et chaussées*, who has just prepared a voluminous report upon his system. M. Levy induced the government to authorize a trial of his system in 1888, when he laid down an installation upon the Marne, the Saint Maur, and Saint Maurice Canals, a distance of 5200 meters. This installation presented nearly all the difficulties that could be met with in such an undertaking, so that, if successful, there could be no question as to its efficiency for the general purposes of canal traction."

The experiment was tried first on a single section of the canal, and, this operating well, the government gave permission to complete the entire work. There were many special difficulties to be met. "This extension was a particularly awkward undertaking from the fact that it had to serve the port of Charenton, which has a length of two hundred and fifty meters, had to pass underneath a tunnel six hundred meters in length, had to go through the Gravelle lock, to which entrance is made extremely difficult on account of a bridge and a sharp curve, and had to cross a branch of the canal of Saint Maur by a single span of one hundred and twenty-one meters, to say nothing of the numerous curves that had to be met along the route. The installation comprises an endless cable that starts from the Gravelle lock, and, after following on one side of the canal, crosses at Charenton and returns on the other side. A second endless cable makes a similar circuit from the Gravelle lock to the river Marne by way of the Joinville tunnel. Special attention has been given to facilitating the attachment of the towing rope to the cable, and this is effected by the means of short lengths of rope that hang from the cable at regular intervals, and are provided with an ingenious clutch. The boatman can attach his tow-rope to the clutch in a few seconds without leaving the boat, and by merely pulling a lever the boat is loosened in a moment. The principal feature in this system is the ingenious method that has been adopted to prevent the cable slipping from the pulleys. This is done by constructing the pulleys, where necessary, with a serrated flange, so that the towing rope will enter one of the notches, and will leave it at the other side when the pulley has made a partial revolution. While plenty of freedom is thus left for the towing rope to pass over the pulley, the flange will prevent the cable from being pulled away. This principle has been developed to a singular extent at the curves, where the cable has to pass outside the support.

"The horizontal pulleys which at first gave so much difficulty have been replaced by oblique pulleys. In this new system the upper face is star-shaped, the flange bearing four or six prolongations that are made almost semi-circular in form, so as



CANAL ROPE TOWING STANDARD

to facilitate the entrance and release of the cable. These oblique pulleys have a diameter inside the groove of two meters. Of course, in the position in which the pulley is placed, the cable exerts a constant strain upon the flange, but the star-like projections are made sufficiently large to preclude the possibility of the cable escaping."

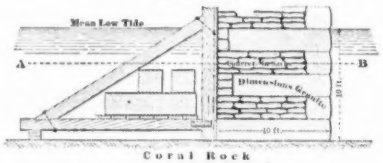
The illustration shows how the difficulty introduced by curves has been met. Of the degree of success achieved some doubt remains. It is the general opinion of engineers "that nothing could be more satisfactory if the cable could be worked in a perfectly straight line, but, where the cable

has to be turned in different directions by pulleys of all shapes and sizes and sometimes placed two and three together, the friction must necessarily result in an enormous waste of power, to say nothing of the wear and tear of the cable. The installation upon the Saint Maur and Saint Maurice Canals has never passed much beyond the experimental stage, and the work which it has done has certainly not justified the cost of the installation. It is believed that the system can only be economical upon canals with a heavy traffic. With a traffic of a million tons a year the cable traction could be employed with great advantage, and from this point the economy would increase in proportion to the augmentation of traffic, until an economy of fifty per cent. could be effected upon the present cost of working, with a traffic of from three to four million tons. As there are many canals in the north of France fulfilling these conditions, the system is at the present moment being experimented with in view of its further extension, and it is likely that an installation will be laid down shortly on the canals in the Loire. The government of Holland is also carrying out experiments upon the Aisne Canal adjoining the Marne, where the first section has already been laid down in the Billy tunnel. Similar experiments have been carried out for some time past by the German government upon the canal from the Oder to the Spree, and the results are being looked forward to with great interest. Though the system has not so far been an unqualified success from an economical point of view, it is the opinion of engineers in France that it has a great future before it, and that it will be used extensively upon canals carrying a heavy traffic."

Sea-Wall at Fort Taylor, Key West, Florida.

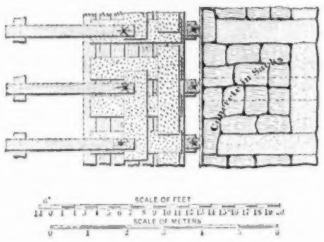
A NOVEL method of constructing a sea-wall at Fort Taylor is described in a paper by Lieutenant-Colonel Jared A. Smith in the *Journal of Engineering Societies* for November. When this paper was read, it elicited a spirited discussion, which, on the whole, seems to confirm the value of the innovation. This method, illustrated in the accompanying engraving, is, in substance, the use of dry concrete in partially-filled bags, which, after submergence, may be rammed to compact the concrete. If the bags are completely filled, they burst when rammed, but the allowance of about one-fourth unfilled space allows the ramming to be done thoroughly and safely.

CROSS-SECTION.



Old gunny-bags that had been filled with sand for defences in war-time were employed. They were of very loose material, about three feet in length and two feet in width. Wet concrete has been used in bags, but this use of dry concrete for the purpose of rebuilding a sea-wall without a coffer-dam is probably, as Col. Smith thinks, the first recorded instance of this

HORIZONTAL SECTION ON LINE A-B.



method of construction. The stones had also to be laid in mortar, and the problem of doing this under water was ingeniously solved. "The first stone, a long stretcher, was laid upon the bottom, a formation of coral, which had previously been cut in steps with level tops to receive the stones upon an even bed. To lay the stones in mortar was a problem. I purchased some narrow and very thin muslin, and had the masons spread one piece of muslin with mortar about half an inch thick, and laid another piece of muslin over the mortar, precisely as one would make a mustard plaster for the sick chamber. The men

that were employed as laborers were all amphibious, I am certain, for without protection, save one or two flannel garments, they would go down to the bottom and stay until the average man would have been drowned; then they would come up for a minute or two, blow a little, and go down again.

"When the stone had been lowered nearly to the bottom, two men drew the sheets containing the mortar-bed under the stone, which was then put in place and rammed down thoroughly with long-handled rammers, the bottom being directed by one of the divers, in undress, and the top being worked by men on the platform. The locating and leveling of the stones are matters of detail, which need not now be described. When a header was laid, the mortar between sheets was wrapped entirely around the bed and build. When an entire course had been built in this way, the backing of concrete was put in. It was made of Rosendale cement and coral sand in the usual proportions. Some chips from the granite and fragments of bricks were used to complete the concrete mixture."

The wall was backed with a solid timber structure, as shown in the cuts. "The temperature of the water was about 84°. The dry bags were handed to the men below the water, who put them in place carefully and rapidly, and they were thoroughly rammed in single layers of a thickness of about six inches."

Several hundred bags were charged with the concrete, and then were placed in position and rammed immediately. "It was an amusing sight to see hands sticking up out of the water all along the line, passing down concrete bags, without the appearance of a head save at what seemed long intervals, when a man would come up and blow for a few minutes before returning to his work under water. In that way the concrete was placed until it was fully up to the level of the course of masonry, when the same process was repeated by putting on another course of stone and backing it with concrete. When the wall had reached the low-water level, the concrete was placed in the ordinary manner."

The cost of the concrete was $7.08 per cubic yard. The overseer at Fort Taylor states that this concrete, put down in 1874, is an entire success, having become much harder than the coral rock of the island. Col. Smith states that the wages of the "amphibious creatures" employed to put down the concrete were the same as those of common laborers.

The Force of Tornadoes.

AN active discussion of the effects of tornadoes upon bridges and analogous structures, and the resisting power of the latter to lateral wind-pressure, was conducted in the correspondence columns of *Engineering News*, in the summer of 1893. Both theoretical and practical points were considered. The discussion has been revived in the same paper (Dec. 20) by an editorial which, after mentioning an instance of the destruction "of a 533-feet span of the Louisville and Jeffersonville Bridge under what was claimed to be an extraordinary wind pressure," calls attention to the meager knowledge of the pressure per square foot which winds may sometimes exert. Theoretically, air, moving at a given velocity, exerts upon a square foot of flat surface a pressure that may be computed; but it is impossible to state the velocity which winds produced by natural forces may attain. The "pressure per square foot which may be exerted by a tornado, ... in view of the rapid increase in steel skeleton buildings of great height, most of them built without wind-bracing, ... is certainly a matter of much interest to engineers."

"Perhaps the best evidence we have of maximum force exerted by a tornado is the well-authenticated case of the lifting of a locomotive from the rails at East St. Louis some ten or twelve years ago. The locomotive was lifted entirely clean off the rails and set down right side up at one side of the track, so as to make it certain that the force was sufficient actually to lift the locomotive, and not simply to overturn it. What would happen if a wind of such intensity should strike a modern ten-story or twenty-story office-building we leave our readers to compute, on whatever

assumptions seem to them reasonable."

The further collection and recording of instances of great wind-force is recommended. Following the advice, a letter from James W. Way, chief engineer of the Missouri Pacific Railway, is presented. This letter contains a report prepared by the superintendent of the Iron Mountain Road Division, describing a cyclone that struck that line on the 12th of last September.

"The cyclone crossed the track about half a mile west of Charlestown, and, from a personal interview with the people living in the course of the same, they describe it as coming from the south, making a roaring sound and rolling like a large barrel tossing up and down. It was about forty feet wide, and took houses and trees as fast as it came to them; when it reached our right of way, on the south side, timbers and trees were being carried along with it. It then lowered to the fence and took it all away, and from there bounded to the rear coach of No. 47, throwing the car thirty feet from the track, the rear coach evidently dragging the balance of the train with it. The force was going upward and did not take our fence on the north side, nor did it come down until it reached a point two hundred feet north, when it again touched the ground, taking large trees and outhouses, and then rose and crossed our Belmont Branch without any damage. The train was running about eighteen miles per hour, and only ran thirty feet after being raised from the track. At the point where the derailment occurred, the track was first-class, with good sound ties. A large tree struck the side of the rear car, making a large hole. A board was blown through the engine cab window."

Mr. Way adds to the report the remark that these "twisters," as they are called in the region named, "are very peculiar, and their force is not direct. . . . On the contrary, they have a rotary motion which is irresistible." Upon this statement the comment is made that "certainly a force which is capable of picking up a locomotive may be described with considerable accuracy as 'irresistible'; and a force which catches up a passenger car and throws it thirty feet from the track might fairly be included in the same category." From a calculation based upon the estimated weight of the car, and the distance to which it was thrown, the conclusion is reached that a pressure of at least one hundred pounds per square foot must have been exerted.

Wind Pressure.

APROPOS of the discussion of "The Force of Tornadoes" in *Engineering News*, elsewhere reviewed, *The Engineer* (London, Nov. 30) has an editorial on "Wind Pressure," which further admits the need of more study of the subject and the collection of additional data relating to it. Speaking of the memorable collapse of a portion of the Tay Bridge, "with its attendant lamentable consequences," it says that, as a result, "engineers felt themselves obliged to examine theoretically and practically, and more closely than they had previously done, the phenomena associated with the action of the wind. It is not that the force, the violence, the impactive and the concussive effects of winds varying both in velocity and pressure, upon bridges, roofs, chimneys, and, in fact, all engineering and architectural structures exposed to their fury, were not previously recognized by scientific and technical writers, and even some allowance made for them by designers; but the whole question, which is exceedingly important, had certainly not received that attention and consideration which it unquestionably both deserves and demands. Engineers were accustomed to regard these effects in the light of perhaps possible but barely probable contingencies, which in the majority of instances were too remote and uncertain to be included as a factor in the calculations. It must be admitted that at that time there was a great paucity of real information,—that is, of information of a character which would permit of trustworthy deductions being made, and upon which could be based mathematical analyses and investigations resulting in tangible and workable conclusions. At the present time, notwithstanding the value of the evidence afforded by the construction

of the Forth Bridge, there is a great deficiency in the experimental data connected with the subject; although now sad experience has amply demonstrated that what were formerly considered as merely possible, or extremely improbable, occurrences have passed into the category of those which have actually happened. For years past most valuable and interesting meteorological observations have been undertaken and accurately recorded, both in our own and other countries, which constitute a mass of highly useful data. From these, in connection with other known facts, the relation between the velocity and pressure of the wind has been ascertained with a precision and fidelity which do not admit of controversy. But, while establishing this generally received relation, the exact value of the coefficients are left undetermined."

Moreover, it is shown that, in a calculation of wind pressure exerted upon a roof, the data are "so incomplete and indeterminate" as to require an assumption that "may vary between the somewhat wide limits of nine pounds and ninety-three pounds per square foot." Pursuing the subject further, one of the reasons supposed to account for the destructive action of winds is in the isochronism of the wind impulses with the "structural vibrations set up." Certainly, if wind comes in puffs, keeping time with the vibrations it sets up in a structure, its force, added to the momentum of the swaying mass in the same direction, would make a sum of strain far beyond what the wind by itself could exert upon the surface of an entirely rigid mass, such, for instance, as the face of a cliff. It is also thought that more attention ought to be given to the effects of deflection of winds by local conditions. "The separate and distinct currents formed by the interposition of an immovable surface to the natural path of wind waves in their attempts to find an outlet very often re-combine, and, aided by continuous reinforcement, ultimately assume a condition analogous to that of an accumulated head of water. It is well known that tremendous local pressures are produced from this cause, and it is possible that the unknown maximum may be yet found under these conditions, though they are fortunately more exceptional than general." The effect of dead weight in neutralizing the *vis viva* of winds, and the fallacy of the belief that a girder of the open web type on the windward side of a bridge will effectually protect the one opposite to it on the leeward side, are pointed out.

Testing Water Service Pipes.

Engineering Mechanics describes an English system for testing water-mains and detecting leaky fittings in houses without entering the buildings. In this method, known as the "Deacon System," by an arrangement of stop-valves any particular street can be supplied from one main only, whilst the remainder are fed by the other. A Deacon water meter fixed on a by-pass to the service main measures the supply to the street isolated, as described above, and records it automatically on a strip of paper, moved by clockwork, whilst a couple of pens operated by an accurate clock also make marks on the same paper every six seconds. In practice, the turn-cock, before setting out for the isolated street, compares his watch with this clock, and on reaching his destination he proceeds to turn off house after house, noting the time at which each stopcock is closed. A comparison of this list and of the meter record the next day shows the houses having leaky fittings. It is stated that the method has proved quite satisfactory in practice.

Industries and Iron says that M. René Baudouy, concessionaire of the Salonica-Dedéaghatch-Constantinople line, has applied to the Government for the concession to build a railway between Feredjik where the Salonica line joins that of Dedéaghatch, and Rodosto, on the Marmora. The projected line would run through one of the most fertile and productive parts of the province of Adrianople.

THE Simplon Tunnel through the Pennine Alps is the subject of a series of illustrated articles begun in *The Engineer* Jan. 4, dealing with engineering features of this great work.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Bridges.

†27637. Revised Plan of Light Suspension Bridge to be Erected Over Tuichoug River, South Lushai Hills. Ill. Banerji (I E-Nov. 10.) 900 w.

*27686. The Foundations of Newburn Bridge, Northumberland. John Henry Barker (C G-Dec 7.) 1100 w.

27812. The Hudson River Bridge (Sc A-Dec. 22.) 700 w.

*27991. The Tower Bridge. Ill. (I C B-Dec. 14.) 1000 w.

28008. Bridging the Hudson River at New York City. Editorial (E R-Dec. 22.) 1100 w.

28009. The Report of the Government Engineers on the Maximum Practical Length of a Stiffened Suspension Bridge (E R-Dec. 22.) 900 w.

†28027. Anas Bridge, Godra-Rutlam Railway. Ill. (I E-Nov. 24.) 700 w.

28216. Plate Girder Swing Bridge over Bronx River, New York City. Ill. (E N-Jan. 3.) 900 w.

Canals, Rivers and Harbors.

*27550. The Canal Aqueduct at Briare. Ill. (E-Nov. 30.) 2800 w.

27606. The Hamilton Water Power and Canal Scheme (C Eng-Dec.) 1000 w.

27608. Georgian Bay Canal and Lake Simcoe Water Power. Thomas C. Keefer (C Eng-Dec. 1.) 700 w.

27609. The "Deep Water-Ways" Raid on the Public Treasury—A Growing Danger. Editorial (R A-Dec. 7.) 1300 w.

27624. The Nicaragua Canal. Editorial (R G-Dec. 14.) 1400 w.

27625. The Manchester Ship Canal. Editorial (R G-Dec. 14.) 1200 w.

*27689. Cable Haulage on Canals (Eng L-Dec. 7.) 1500 w.

*27778. Canal from the Hunter River to Port Stephens, and Improvements in the Harbor of Newcastle. J. Rorison (A M S-Nov. 17.) 1500 w.

*27785. Concrete Construction in the Illinois and Mississippi Canal. Ill. J. W. Woermann (J A E S Nov.) 7000 w.

*27789. The Construction of a Sea Wall at Fort Taylor, Key West, Florida. Ill. Jared A. Smith, with Discussion (J A E S-Nov.) 2800 w.

*27790. Improvement of Cuyahoga River. Jared A. Smith, with Discussion (J A E S-Nov.) 800 w.

*27974. The Sault Ste. Marie Canal, Canada. Ill. (I & I-Dec. 14.) 800 w.

†27994. The Sirhind Canal and Its Difficulties. Ill. E. A. S. (I E-Nov. 17.) 1500 w.

28035. The Harlem River Canal. Ill. (R G-Dec. 28.) 800 w.

28244. The Work of Improvement of the Mississippi River. William Starling (T-Jan. 1.) 4800 w.

*28325. Sheffield and South Yorkshire Navigation Company (Eng L-Dec. 28.) 2300 w.

Hydraulics.

*27558. The Philæ-Assuan Dam Project. W. E. Garstin (A L-Nov. 30:) 2200 w.

*27565. Progress of the Cataract Construction Company's Works at Niagara (N-Nov. 29.) 800 w.

27830. The Danger of Tapping Water-bearing Sand Under Pressure (E N-Dec. 20.) 500 w.

†27995. Well Sinking Facts. F. J. E. Spring (I E-Nov. 17.) 800 w.

*28036. The Hydraulic Ram. C. E. Houghton (S J E-Dec.) 2800 w.

28042. The Discharge of the Niagara River. E. H. Ruffner (E N-Dec. 27.) 2400 w.

28179. A Paradox in Hydraulics—The Impact Pump. Ill. Gus C. Henning (A M-Jan. 3.) 2200 w.

*28197. The Flow of Water Through Glazed Pipes. Emmett Steece (P-Jan.) 400 w.

Irrigation.

*27458. Ancient and Modern Irrigation in Egypt.—Object Lessons of Practical Value. Ill. F. Cope Whitehouse (E Mag-Feb.) 3000 w.

*28045. The Voice of the Great West. (Irrigation discussed.) William E. Smythe (Mill-Dec.) 2000 w.

Miscellany.

*27484. Wind Pressure (Eng L-Nov. 30.) 2500 w.

*27593. A Formula for Pile Driving. Charles Haynes Haswell (I & I-Nov. 30.) 1100 w.

*27692. Brunel and the Thames Tunnel (I C B-Dec. 14.) 3200 w.

28034. The Simplon Tunnel. (Abstract.) Ill. W. G. Triest, Jr. (R G-Dec. 28.) 3000 w.

†28046. The Asphalt Question. S. F. Peckham (J A C S-Jan.) 3000 w.

28247. Influence of the Size of Grain on the Strength of Cement and of Cement Mortar (R G-Jan. 4.) 600 w.

28251. Substructures. (Extracts.) George S. Morison (R G-Jan. 4.) 5500 w.

Serials.

22670. The Iron Gates of the Danube. Bela von Gonda (Eng L-Began June 1—Ended Dec. 21—6 parts—30 cts. each).

26914. Waterways vs. Railways (R A-Began Nov. 16—5 parts to date—15 cts. each).

27521. The Engineering Improvement of the River Clyde. Ill. James Deas (E Rev-Began Nov. 20—2 parts to date—30 cts. each).

28259. Dam Construction. Ill. A. R. Beardsley (Am M-Began Jan.—1 part to date—30 cts).

We supply copies of these articles. See introductory.

DOMESTIC ENGINEERING

Storage of Rain-Water.

A SERIAL which has been running for some time in *The Builder* (London), under the title "Details of Rural Water Supply," contains, in the issue of that paper for December, useful information relative to the storage of rain-water, which in some locations must be relied upon as the chief source of potable water. In many places where rain-water is not the only potable water conveniently obtainable, it is needed to supplement other supplies in dry weather; and it seems to be generally agreed by physicians and sanitarians that it is more wholesome than the average of water obtained from streams or from surface wells, provided proper care is bestowed upon its collection and storage. Tabulated statements of the amount of annual rainfall are only of value as applied to the particular localities for which the tabulated observations have been made; but the following rules may be used for computing the supply of water obtainable from a given collecting surface in any locality whose annual rainfall has been determined.

"1. Multiply the area in square feet by half the annual rainfall in inches; the product is the quantity of water in gallons, approximately (Parkes's 'Practical Hygiene').

"2. Multiply the area covered by the roof in square feet by the average rainfall, also in feet, and divide the result by one hundred; the product is the average supply in gallons *per diem* for a very dry year (J. Wallace Peggs, 'Transactions, Sanitary Institute,' vol. xlv).

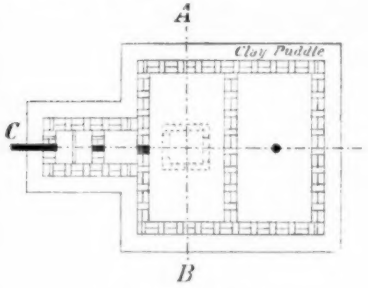
"3. Multiply the lowest recorded rainfall in feet by the collecting area in square feet by 0.015; the product is the average number of gallons per day, including a small allowance for loss in the collection ('Water, its Composition, &c.,' by Joseph Parry, C. E.)."

In applying these rules, what engineers call the "projected area" must be used; that is to say, the inclination of the roof does not increase the amount collected over what would fall on a flat surface having a width bounded on two sides by the eaves, and a length equal to the distance between the gable-ends.

Though rain-water is usually wholesome in rural districts, there may be conditions which will contaminate it. If the air contains polluting substances, they may contaminate the water falling through the atmosphere; and it is quite certain that in this way dust and small insects, as well as germs of bacteria, are sometimes collected during a period of violent rainfall. But these contaminations are rarely brought down in deleterious quantity except when the collection of water is made from roofs of buildings which are of a character, and are situated favorably, to collect and hold objectionable matters in dry weather, to be washed off at the first heavy rainfall. Thatch, felt, lead, and zinc, are specially to be shunned as collectors of potable water. Thatch and felt are of a nature to hold soot, dust, and germs, and rain-water has a solvent action upon lead and zinc, thus taking up a portion of these metals. Probably slate and tin are the best materials for roofs intended to collect water for domestic purposes, and the cleanliness of all roofs so employed should be carefully looked after, as the excrements of birds, bats, and other flying creatures are almost sure to be deposited upon them more or less.

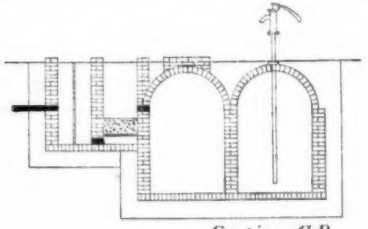
"The first portion of the rainfall collected from roofs, especially after a long period of dry weather, is usually of an impure nature, on account of the soot and other matters which have had time to accumulate. In order to prevent this portion from entering the storage tank, mechanical appliances, known as 'rain-water separators,' have been devised. These consist of vessels into which the rainfall is directed before passing into the storage tank, and which are so constructed as to collect the first portion of the flow, and, when full, to

cant over, emptying their contents to waste, and at the same time placing the flow of water from the roof in direct communication with the storage tank. When the flow has ceased, they return automatically to their original position.



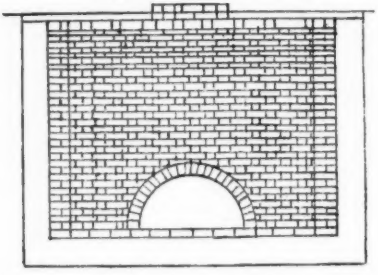
PLAN OF CISTERN.

"The rain-water may be stored in overground and underground cisterns, or reservoirs. The former have the advantage of



Section C.D.

enabling the water to be drawn directly by means of a tap, but are generally more expensive, and the water is subject to changes



Section A.B.

of temperature. The underground reservoir necessitates pumping, and is more liable to permit of pollution. The water hould be strained through a copper strainer to keep back leaves, &c., and should be filtered before admission into the storage-tank. The filtering material may be sand, polarite, or other suitable substance. The tank should be efficiently ventilated, and have a sufficient covering of earth so that the water may be kept at an equable temperature; and should be, if possible, provided with a wash-out valve for cleansing purposes. When the roof surface is insufficient, a small area of ground may be fenced off, and either underdrained by means of agricultural tiles, or the surface may be covered with tiles or concrete, and the rain-water falling upon it taken by means of pipes to a storage-tank." The accompanying engravings illustrate the construction of a brick underground tank for storing rain-water, which is recommended for the purpose.

Gas-Heating for Greenhouses.

NOTWITHSTANDING the cost of gas as fuel for greenhouse heating, Mr. William Chester, in a recent paper (*Journal of Gas Lighting*, Nov. 27), expresses the view that, when all things are properly considered, it will compare favorably—at least in small installments—with any other system of heating. It certainly possesses the great advantage that its uniformity of action supersedes the necessity of an attendant to supply fuel at stated periods. Another advantage is the ease and certainty with which it can be made to maintain any required temperature by the aid of a thermostat. Thus artificial climatic conditions most favorable to health and growth of plants may be secured, and the different temperatures needed for the successful cultivation of plants native some to tropical, some to temperate regions may be easily maintained in different compartments of a conservatory.

"If we take a moderate-sized conservatory of the lean-to type, twenty feet long, twelve feet wide, and ten feet high at the top, sloping to six feet at the eaves, we shall have a superficial area of glass amounting to about four hundred and forty square feet. Each square foot of glass surface is capable of cooling one and one-fourth cubic feet per minute of heated air

in the interior of the conservatory to the temperature of the atmosphere outside; so that, with a glass surface of four hundred and forty superficial feet, five hundred and fifty cubic feet of air will be lowered to atmospheric temperature per minute. In order to maintain constant temperature in the conservatory, it will, therefore, be necessary to provide so much heat per minute as will raise the temperature of five hundred and fifty cubic feet of air the number of degrees which is the difference between the interior and exterior temperatures of the air,—say, about 30° F., in a conservatory where the normal interior winter temperature required is about 50° F., and in a locality where the exterior temperature seldom goes lower than 20° F. or 12° below frost." Of course in such situations "the atmospheric temperature often gets lower than 12° of frost; but not in sheltered places, such as those in which conservatories are usually built.

"Now, five hundred and fifty cubic feet of air represents about forty-five pounds in weight; and, the specific heat of air being 0.2375 as compared with water, we shall require to develop as much heat as will raise the temperature of 10.6 pounds of water 30° F. per minute, which is 318 British thermal units, or 19,080 units of heat per hour."

The heat in the system proposed is to be distributed by steam or hot water precisely as is now done when coal is used as fuel, a boiler furnace specially adapted to the use of gas as fuel being supplied. The work above named could, it is estimated, be done with seven hundred and twenty cubic feet of gas per day, and, as the services of an attendant are not needed, the cost of gas would be the chief expense.

"A specially constructed boiler, capable of maintaining the above high ideals, has yet to be made. There are none which yet come up to the mark, and some of them fall very far short of it. The boiler must be constructed with a studded bottom and interior tubes with gills or studs on the inside for rapidly absorbing the heat and transmitting it to the water. It must be of such length as to absorb all the heat developed by the combustion of the gas, except just the amount necessary to ensure a continuous upward current; and it must be boxed in round the burner, so as to admit no more air than is just sufficient for the complete combustion of the gas. At the top it must be provided with a cover and flue-pipe for carrying away the products of combustion. The flow and return openings must be not less than the water-pipes to be heated,—say, three inches in interior diameter,—and the burner must be constructed to consume the maximum and minimum quantities of gas with perfect combustion. It must not fire back under any conditions; and when not required it must automatically shut off all the gas except the supply to a small pilot jet, which will at once re-ignite the gas at the burner when further heat is required. The consumption of gas must be controlled by the temperature of the conservatory, and automatically increased or diminished within fixed limits, which may easily be determined. When we have such a boiler,—and there are no inherent difficulties in its construction,—we shall have a wide field for the further development of coal gas for conservatory heating. . . .

"My principal object in writing this paper is to direct the attention of makers into this particular groove. It will be a profitable one both for them and for the gas producer."

An experiment with a gas-burner of the "ring" type in a conservatory having 1956 square feet of glass and a cubic capacity of 19,162 feet, with heating pipes three inches in diameter and having a surface area of 431 square feet, and with a copper tubular boiler fifteen inches in diameter and two feet high (diameter of tubes one inch), enabled the building to be kept at a temperature of 66° F., with an outside temperature of 46° F. Sixty cubic feet of gas per hour were consumed to obtain this result. Water passed from the boiler at a temperature of 182° F. and returned to the boiler at a temperature of 87° F. In the installment, however, the following defects exist: "(1) The heating surface is deficient, the effluent gases being allowed to escape at too high a temperature. (2) Too large a proportion of air is per-

mitted to enter with the gas. (3) The flow and return pipes at the boiler are much too small. (4) The radiating pipes are much too large for the boiler,—*i. e.*, a much larger boiler is necessary for effective work."

Sanitation of Hospitals and Infirmaries.

A PAPER recently read by Mr. Keith D. Young before the Architectural Association touches all the aspects of this subject. A rather unique division of hospitals into two classes attracts attention. One class is for private aid, the other for public protection. The first class includes those "devoted to the relief of the sick and injured poor." The second class comprises "hospitals for the treatment of infectious fevers," to which rich and poor may alike be removed when safety to the health of the community demands such a measure.

"The rules of hospital hygiene are in principle simple enough. That which makes the healthiest house makes likewise the healthiest hospital,—the same fastidious and universal cleanliness, the same never-ceasing vigilance against the thousand forms in which dirt may disguise itself, in air and soil and water, in walls and floors and ceilings, in dress and bedding and furniture, in pots and pans and pails, in sinks and drains and dustbins. It is but the same principle of management, but with immensely greater vigilance and skill; for the establishment which has to be kept in such exquisite perfection of cleanliness is an establishment which never rests from fouling itself—not even the least odorous of such products—which ought not to be regarded as poisons."

"The air of a hospital ward is liable to contamination from the following causes: 1, the evacuations of effluvia from the bodies and excreta of patients; 2, the presence of suppurating wounds, with their necessary dressing, poultices, &c.; 3, foul linen bedclothes, &c. And these necessary and unavoidable conditions, common to all hospitals, may be aggravated and their danger intensified by: (a) insufficient air space; (b) insufficient ventilation; (c) inadequate or improper arrangements for the removal of refuse of all sorts; (d) faulty arrangement of buildings."

Striking examples of unsanitary conditions are cited, some of them so disgusting that their description is decidedly unpleasant reading. One of these—the old Hôtel Dieu in Paris, France—is stigmatized as a "monstrous pile more fit to prolong sickness, to destroy, than to re-establish and preserve health."

But the topic treated most at length is that of ventilation, in which the following prevalent faults, existing particularly in old hospitals, are enumerated,—insufficient air space, without which good and efficient ventilation becomes impossible, and insufficient supply of fresh air, less than two thousand cubic feet per hour for each patient being thus considered. In order that this amount of air may be supplied without unpleasant and injurious draughts, the space in wards should be so proportioned that the change of air will not take place more than three times per hour, which means at least one thousand cubic feet of space for each patient. But it is considered difficult to lay down hard and fast rules for apportionment of space. Natural ventilation, as distinguished from forced or artificial ventilation, is pronounced wholly inadequate for hospitals.

The sterilization of air from fever wards is of recent introduction, and is simply and easily accomplished at the Bradford Corporation Hospital. "Fresh air, capable of being warmed when necessary by passing over hot-water pipes, is admitted to the wards in the floor at the foot of each bed, and also at certain points in the opposite wall. The whole of the vitiated air is drawn from the ward through openings at the ceiling-level into a trench, at one end of which is a powerful furnace; part of this air is used to promote the combustion of the fire, the remainder being passed through the furnace and exposed to a temperature estimated to be 800 degrees F. All the windows in the ward are hermetically sealed. For sufficient reasons, I am not able to put before you any statistics as to the success of this system. The proof of success in an appliance of this kind is a matter for the bacteriologists and the mi-

croscope; and we have yet to see whether a ward constructed after this fashion fulfils every requirement, not only of the sterilization of the air, but also as a suitable place for the treatment of small-pox. The point, however, I wish to impress upon you is that there is no justification whatever for applying such a system as this to wards for scarlatina, or any other infectious fever. The fact that scarlatina, the most important of these diseases, does not spread beyond the walls of the ward is well recognized; and, this being so, the necessity for any system of sterilization of air vanishes."

Drainage is another point of equal importance with ventilation. "In all sanitary fittings including sinks, lavatories, and baths, simplicity of form and cleanly appearance are desirable. They should also, as far as possible, be self-cleansing." Glass shelves are recommended for operation theaters where extreme cleanliness is of the highest moment. "For floors, the so-called fire-proof floor of carefully-laid terrazzo is the best thing to be had. A window should always be put between the end-bed and the end-wall. This may be as narrow as you like, but it must not be omitted." The reason assigned for this is the greater difficulty of effecting good air-circulation around beds placed in corners. The best wall-surface yet obtainable is Keene's cement surface, painted and varnished. The laundry should be isolated, as also should be the mortuary building, and the latter should have walls of glazed bricks and floors of asphalt.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Heating and Ventilation.

*27563. The Heating of Greenhouses and Conservatories by Coal Gas. William R. Chester (J G L-Nov. 27.) 1500 w.

27802. Relation of Air Volume to Temperature. Walter B. Snow (H & V-Dec. 15.) 1500 w.

†27847. School Room Ventilation as an Investment. George Henry Knight (P S M-Jan.) 1500 w.

27868. Improvements in Greenhouse Heating. Samuel Burns (Met W-Dec. 22.) 3800 w.

27869. Heating and Lighting of Windsor Castle (Met W-Dec. 22.) 500 w.

*27872. The Present Status of Steam and Hot Water Heating. Leicester Allen (D E-Dec.) 1100 w.

*27873 Overhead Heating in Greenhouses. Ill. J. P. Ring (D E-Dec.) 400 w.

*27874. Ventilation. Henry B. Baker (D E-Dec.) 1700 w.

*27875. Hot Air Furnace Heating. Ill. (D E-Dec.) 800 w.

27893. The Distribution of Temperature in Steam Heated Buildings. George De Witt (S E-Dec.) 800 w.

28040. Pressure Hot Water Heating (Met W-Dec. 29.) 900 w.

28083. Hot-Water Heating Plant in a Brooklyn Residence (I. S. Coffin's.) Ill. (E R-Dec. 29.) 900 w.

28267. Heating of the Columbus Building in Chicago. Ill. (E R-Jan. 5.) 1000 w.

Landscape Gardening.

27605. Imagination in Gardening. M. C. R. (G & F-Dec. 12.) 1600 w.

28155. Utility and Landscape. Sylvester Baxter (G & F-Jan. 2.) 1800 w.

Plumbing and Gas Fitting.

*27580. The Sanitation of Hospitals and Infirmaries. Keith D. Young, with Discussion (B-Dec. 1.) 10000 w.

*27871. A Remedy for Substitution. E. Baggot (D E-Dec.) 1000 w.

23269. Improved Method of House-Drainage. William Paul Gerhard (A A-Jan. 5.) 8000 w.

Miscellany.

*27774. The Site and Soil. Professor Carfield (I C B-Dec. 7.) 1000 w.

*27999. Healthy and Unhealthy Homes. Dr. Stirling (S R-Dec. 15.) 5500 w.

28352. Garbage Disposal. L. L. Summers (E E-Jan.) 800 w.

*28358. The Quality of Water for Domestic and Technical Purposes. Stephen J. Lett (S R-Dec. 29.) 7800 w.

Serials.

26907. Hot Water Heating and Fitting. J. L. Saunders (H & V-Began Nov. 15—2 parts to date—15 cts. each).

27214. Combination Heating. Ill. J. W. Hughes (Met W-Began Dec. 1—2 parts to date—15 cts. each).

27783. Mechanical Heating and Ventilation Motors. Ill. M. C. Huyett (I A-Began Dec. —1 part to date—45 cts).

27848. The Names and Uses of Stops and Faucets. Ill. Calvin Fulton (S P-Began Dec. —2 parts to date—15 cts. each).

We supply copies of these articles. See introductory.

ELECTRICITY

A Vast Electric Street-Railway System.

THE finest example of modern electric street-railway engineering in this country, or in the world for that matter, is undoubtedly that of the Philadelphia Traction Company, an admirable description of which, with many excellent and well-chosen illustrations, is given by Professor Hermann S. Hering in the *Electrical World* (Oct. 20, 27, Nov. 3 and 10). Want of space precludes mention of many interesting features of this enormous plant, but some idea of its dimensions and leading characteristics may be gained from the following synopsis. The company at present operates the equivalent of 119 miles of single-track road by electricity, 34 miles additional by cable, and 25 miles by horses. It contemplates the electrical equipment of all its present lines, and the extension of a number of new lines into the suburbs, at an early day, which will give an ultimate aggregate of about 300 miles. There are four power-houses, aggregating at present about 11,550 horse-power, but intended for an ultimate capacity of 19,800 horse-power. The largest of these stations is that at Thirteenth and Mount Vernon streets. The present equipment of this station comprises five Westinghouse vertical compound engines, each coupled directly to Westinghouse four-pole generators of 600 horse-power each. To these are shortly to be added four of the immense railway generators shown by the Westinghouse Company at the World's Fair of 1500 horse-power capacity each, driven direct by Wetherill-Corliss twin-tandem compound engines of equivalent capacity. The switchboard is 96 feet long and controls about 100 feeders, but has an ultimate capacity of 250 feeders. The weight of a 1500 horse-power generator, exclusive of the shaft, is 130,000 pounds. It runs at a speed of 80 revolutions per minute, and gives 2250 amperes at 500 volts. It works easily at its rated maximum capacity without heating or sparking at the brushes. Six of these immense machines are to be used by the company, four in the Mount Vernon street station and two in the station at Thirty-third and Market streets. Each of the four stations is provided with a testing room, equipped with a complete outfit of apparatus for testing the underground feeders and the cables through which telephone communication is maintained throughout the system. Very few electrical faults have occurred since the underground feeders have been placed in service. The general system of distribution adopted is that of supplying independent sections of the trolley-wire by means of independent feeders running directly from the power station, thus enabling any particular feeder to be cut out if necessary, without interfering with the running of the cars. The length of each detached section of trolley-wire varies from 1000 to 4000 feet. From three to five feeder connections are made with each section, and, in case of accident to any feeder, the corresponding section can be temporarily connected with the adjacent sections and thus supplied with current. A complete system of return feeders is installed in the conduits and connected with the rails at every manhole. These return feeders run to the switchboard at the power-station, so that practically very little of the current returns through the earth. Some of the feeders contain a very large amount of copper; one of the longest is over 16,000 feet in length, and has a cross-section of 700,000 circular mils. The return feeders are of twisted tinned copper wire, and have a cross-section at the station of 1,000,000 circular mils. There are 52 miles of return feeder cable.

The conduits are composed of a tough iron shell lined with smoothly finished cement concrete to a diameter of about 3 inches. These conduits or ducts are laid in bunches with about 3 inches of concrete between them, about 2 feet below the surface. The manholes are from 200

to 500 feet apart. The length of single duct aggregates about 800 miles. The street poles are of wrought-iron tubing, 28 feet in length and of various thicknesses according to circumstances. They are set 5 ½ feet deep in concrete. 15,000 of these are in use. The trolley-wires are of No. 0 hard copper, and the guard wires of No. 6 silicon bronze wire, supported 18 inches above the trolley wire and 3 feet apart. Lightning arresters are placed on every feeder pole and connected to the return feeder, and a choking coil is placed between the feeder and the trolley wire. The track joints are lace-bonded with No. 0 tinned copper wire, fastened with channel-pins, and cross-bonded every 50 to 90 feet. The joint next to each manhole is tied to the return feeder. The number of cars now in operation is about 400, but it is expected that this number will be doubled in the near future. The average round-trip speed is about 12 miles per hour, and each car averages 130 miles per day. A novel feature of the car equipment is the engineer's test-car, which is furnished with a complete outfit of instruments and is used for inspecting the lines and making tests of the local conditions, both electrical and mechanical, in various parts of the system. Six tower-wagons are used by the company, each comprising a telescoping iron framework which can be raised with a windlass to suit the height of any wire. Each tower wagon carries a full outfit of tools for making repairs, and is kept ready at all times for instant service in emergencies. The station pressure used is 515 volts, and the average current per car in operation is found to be about 10 amperes, or about 7 horse-power, including loss in distribution. The greatest output of current hitherto observed was 6200 amperes for 2½ hours. Professor Hering includes among the illustrations a group of portraits of the engineering staff of the company, with brief notes of the professional career of each man. It is but just to say that it is not often that one sees so fine a group of heads brought together on one sheet. Each one is a notable specialist in his particular department, and has obviously been selected from considerations of merit alone. In conclusion it is not too much to say in praise of Professor Hering's article that it constitutes the most complete treatise on up-to-date electric-railway construction and management within our knowledge, and may be consulted with satisfaction and profit by every one interested in such matters.

Was Morse's Telegraph Invented by Morse?

THERE has been in late years, from time to time, no small amount of discussion as to the share of credit justly due the associates of Professor Morse for the invention of the modern electric telegraph which goes by his name. All the facts in the case, with one or two exceptions, have been so well established by contemporary evidence of unimpeachable character that there is really little or no dispute about them. Such controversy as there has been has mainly turned on the interpretation which is to be put upon these facts. A recent article by G. Wilfrid Pearce, published in *Electricity* (Nov. 21), attacks the claim of Morse in very intemperate language, to say the least, and in support of his position makes some positive statements which, in the absence of further evidence, may well be received with caution. For example, Mr. Pearce states that Morse was examined before "competent officers of engineers" in Paris, and "was obliged to admit that he was not the original inventor of the telegraph, and that the apparatus which he erected in the University of the city of New York was simply a copy of an apparatus which he had seen in Spithead, England." Again, the assertion is made that Morse "did not set about making apparatus until 1835," which is doubtless true as concerns the making of a complete apparatus, though there is good evidence that he made type for his transmitter at a date considerably prior to this; but this is bracketed with the assertion that at this date "there were long lines of telegraph in France which were better than Morse's, and equipped with almost all the devices which Morse attempted to use before Vail appeared on the scene and put the American lines into working or-

der." If there are any historical grounds whatever for these remarkable assertions, it would be interesting to have Mr. Pearce tell us what they are, and especially why they have hitherto failed to come under the notice of painstaking historians. It has never, so far as we are aware, been doubted by impartial investigators that Morse was the actual originator of the first recording telegraph; that he conceived the idea on board the *Sully* in the autumn of 1832; and that he completed and exhibited a working model of the invention in the New York University in 1837. The real question—and it is one in respect to which there has naturally been much diversity of opinion—is whether the work admittedly accomplished by others, especially by Alfred Vail, ought rightfully to be regarded as a mere mechanical improvement engrafted upon Morse's original apparatus, or exalted to the status of a new and independent invention, of which Morse's concept furnished nothing more than the germ and the inspiration. The importance of this discussion lies in the fact that the telegraph of to-day has for the most part discarded as superfluous the very features which Morse was disposed to insist upon as most essential, while it has retained, and doubtless will permanently retain, many of those which were beyond question contributed solely by the genius of Vail. To say, as Mr. Pearce permits himself to do, that Professor Morse was a "Grand Master of Peter Funkism," is obviously not only unbecoming, but untrue. With all due respect to him, we do not think that the truth of history can be successfully vindicated by the substitution of epithets for evidence.

Test of Current-Controllers for Electric Cars.

THE method of controlling the current in operating street-car motors which was formerly employed by the General Electric Company consisted in using a plain rheostat, or artificial resistance, which was thrown into circuit at the moment of starting in order to prevent injury to the motor by too powerful a flow of current. As the car gained in speed, this resistance was gradually withdrawn, as the counter-electromotive force of the motor increased. In running at slow speeds, this device has proved very wasteful of current and consequently of coal at the power-house. Recently an improved method has been adopted, by which the two motors of the car, at the moment of starting, are placed in series with each other and with their respective rheostats. As the speed increases, the resistance is withdrawn, and then a shunt is thrown around each field. Next, the motors are placed in parallel, with half the resistance in, after which all the resistance is withdrawn, and finally, when full speed is reached, the motors are in parallel with shunts around both fields. The *Street Railway Review* (November) gives the results of tests of these respective methods of control, accompanied by graphic diagrams, showing the consumption of current in each method, from the starting of the car until a speed of about twenty-two miles per hour was obtained. The same car was used in both cases,—a sixteen-foot car weighing about fourteen thousand pounds. The time occupied in starting was about eighteen seconds. The diagram shows that the average amperes required during the eighteen seconds with the plain rheostat was 62.4, and with the series-parallel only 42.9,—a saving of about one-third. Another diagram shows that for speed varying from ten to fifteen miles per hour, with the particular car used, the average consumption of current with the plain rheostat was about 23 amperes, while with the series-parallel controller it was only abour 12.5,—a saving of about forty per cent. In addition to the economical advantages of the series-parallel controller, the smoothness with which a start can be made, and the facility of running at different speeds less than the normal, are very desirable features.

Electric Street-Railway Repairs.

IN the *Electrical World* (Oct. 20), Mr. J. B. Cahoon has a forcibly written article urging the importance of a careful and methodical accounting for the cost of repairs in street-railway service, and insisting upon the necessity of constant and

vigilant inspection in every direction. He takes up each department in turn,—engines, boilers, dynamos, cars, motors, track, and line,—and demonstrates the vital importance of looking after all the innumerable details, the neglect of which causes an aggregate loss in the course of a year of an amount of hard cash not pleasant to contemplate. Among other things Mr. Cahoon strongly advocates the payment of firemen at least as much as $2 per day, besides a bonus in the shape of a percentage on the cost of all coal saved beyond a certain amount which is deemed a fair average for running the boilers to produce the steam required. It would seem to be obvious that, if a man's pay depends not on how much coal he can throw in the furnace, but on how much he saves, he will look very sharply after his fires, and will take an interest in the working of the plant which otherwise he would not. "Very few men," says Mr. Cahoon, "stop to think, when they see a leaky steam-pipe, that such leaks represent a direct loss in horse-power; they think it doesn't look very well, but that is about all the attention they give it. If they would, instead of looking at it in that way, only consider for a moment how much coal it takes to turn water into the amount of steam they see coming from such a leak, and recollect that every pound of coal costs money, they would see that it means a loss in dollars and cents and nothing else."

Dynamo-Electricity in Fire-Alarm Telegraphy.

SUPERINTENDENT B. S. FLANDERS, of the Boston municipal fire-alarm telegraph, in *Fire and Water* (Nov. 17), gives an account of certain experiments made by him in the application of dynamo-electric currents on his lines, which are of much interest. For the past year Mr. Flanders has employed a motor-generator driven by a 110-volt current derived from the mains of the Edison Illuminating Company. This machine feeds a group of six fire-alarm circuits, each of which is provided with a rheostat for adjusting the strength of its current. The average current required for each circuit is fifty volts and 0.04 amperes. The number of gravity-cells superseded by this arrangement was three hundred and fifty, and Mr. Flanders states that the capacity of the machine is ample to supply as many additional circuits. As to the results, he says: "The constancy and steadiness of the current thus obtained, together with the facility for instantaneously increasing or decreasing it to meet the varying conditions of the circuits, have thoroughly convinced me, after a trial extending through so many months, that the dynamo is greatly superior in all respects to any form of galvanic battery yet used in the fire-alarm service." The system has been definitely adopted for the new central station which is soon to be equipped under Mr. Flanders's direction.

Grade-Crossing on Electric Railways.

IT is encouraging to see that a State court has at last awakened to the necessity of prohibiting the crossing at grade of an established steam-railway line by an electric surface line. This happened in Pennsylvania, in a recent case which came up at Plymouth in that State, and a decree was issued by the court requiring the street-railway company to build an overhead bridge suitable for its own use and for ordinary travel on the highway in controversy. Although any action having the least tendency to increase the existing dangers at grade-crossings is directly contrary to the repeatedly expressed policy of Massachusetts, the courts of that State, in certain recent cases, have seemed to lean strongly towards the doctrine that municipalities have authority to grant a street-railway company the privilege of putting in such a crossing. Commenting on this state of affairs, the *Railroad Gazette* (Jan. 4) says: "The statutes and court decisions which have been the basis of the law hitherto were made on the assumption that street traffic is slow enough and manageable enough, and small enough in volume, to warrant some laxity or risk in the establishment and management of railroad crossings; and the reasonable limits of such laxity have probably been duly observed,—certainly as well in Massachusetts as any-

where else. But, as must be apparent to any one who stops to reflect a moment, the establishment of an electric line at once changes all these conditions. The cars are run faster than any street vehicles have before been run, and the rules about controlling speed and about the proper place to apply brakes on approaching a crossing are peculiarly liable to be disregarded, on account of the inexperience of the average motor-man. Unless a better grade of men are employed, this inexperience or its equivalent is likely to be a permanent factor in the case. And as every one knows [except possibly a judge. – ED.], a place where the track is rough, as on a crossing, is just where the electric power is most likely to fail or make trouble. And finally, an electric line, suddenly increasing the speed and decreasing the cost of travel, often increases its volume very materially. These considerations make it highly necessary, not only in Massachusetts, but in every other State, that, where the laws do not adequately provide for safety at such crossings, they be at once changed so as to make the necessary provision." Something obviously ought to be done about this matter without delay, as the number of fatal casualties due to these death-traps is increasing at an alarming rate. As the Boston *Post* well says: "It is foolish, absurd, and reckless to authorize grade-crossings of electric and steam railroads, and, if the courts can stop it, the people will be thankful."

Automatic Cable Signaling.

IN the *Electrical Engineer* (Dec. 19) Mr. Patrick B. Delaney gives an interesting *résumé* of the results of a series of experiments made by him last year on the transatlantic cables with a newly-invented signaling apparatus, which appear to have at length conclusively demonstrated the superiority of machine-working over hand-transmission. During a period of three weeks the entire traffic of the direct cable between Ballinskellegs and Halifax was transmitted by machine, the average rate of speed attained being 88 letters per minute, notwithstanding that there was an unusual amount of electric disturbance during the period, from natural causes. At a later date, the unprecedented speed of 243 words per minute was attained on the new (1894) cable of the Anglo-American company between Valentia and Halifax with carefully-timed regular commercial code messages. To appreciate the enormous advance which has been made in the art of cable signaling, since the beginning, it is only necessary to say that the best speed which could be got through the original Atlantic cable of 1858 never exceeded 2 1/2 words per minute, and, even after the successful cable of 1866 had been for some time in regular commercial service, 12 words per minute was considered a good average speed. Mr. Delaney has also experimentally satisfied himself that it is possible to effect automatic translation between the cable and the connecting land lines at each end, without appreciable loss of time in transmission, so that London may now write direct to Heart's Content, and New York direct to Valentia. He also predicts that the time is near at hand when direct automatic transmission will be established between New York and London at the rate of at least 100 letters per minute. A study of what has already been accomplished renders it impossible to resist the conclusion that Mr. Delaney's prediction is destined to meet with a speedy fulfilment.

The Metering of Multiphase Currents.

THE rapidly-increasing application of bi-phase and tri-phase electric currents in electric-transmission plants has rendered radical modifications necessary in the construction of the apparatus hitherto employed for metering uniphase currents. In the *Electrical Engineer* (Jan. 2) an illustrated description is given of the metering apparatus designed by Mr. O. B. Shallenberger of Pittsburg for use in connection with the Niagara plant. The group of instruments comprises an alternating current volt-meter, an ampere-meter, a watt-indicator, and an integrating watt-meter. All these instruments depend for their action upon one and the same principle,—modified in minor details to meet the requirements of each specific applica-

tion,—that of the induction of secondary currents in a movable closed coil.

Rights of Electric Companies in Public Highways.

THE *Electrical Engineer* (Nov. 7) publishes an abstract of a decision recently rendered by the Court of Appeals of the State of New York in a suit of ejectment originally brought by a property owner against a telephone company which had occupied a portion of the public highway in front of his premises with its poles. The court holds that compensation must be made to the owner of the fee for such use of the highway, and that an action in ejectment is maintainable, on the ground that the use is one outside of and beyond the public easement. The State, it seems, can neither appropriate to its own especial, continuous, and exclusive use, nor authorize any corporation to so appropriate, any portion of a rural public highway by setting up poles therein for the support of telegraph or telephone wires.

An Electric Locomotive for Heavy Service.

THE *Railroad Gazette* (Jan. 4) publishes a brief description, with two photographic illustrations, of an electric locomotive which has been built by the General Electric Company for the new belt line of the Baltimore & Ohio railroad, and is to be used for handling trains in the tunnel under the city of Baltimore. Two six-pole gearless motors, one on each axle, are flexibly supported on each truck. The driving wheels are of cast-steel, 62 in. diameter. The cab is spring-supported on the truck-frame, and contains the series-parallel controller and an air-compressor, driven by a small auxiliary motor, which supplies air for the brakes and whistle. The locomotive is of standard gage, is 14 ft. 3 in. long, and weighs 95 tons. It is calculated for a maximum speed of 50 miles per hour, which will be reduced to 15 miles per hour when the maximum draw-bar pull is exerted. The average speed with a loaded train will be about 30 miles per hour. A recent test of one of the completed trucks, being half the complete locomotive, in a tug-of-war with a heavy six-coupled engine of the New York Central railroad, demonstrated that for the same weight on the drivers the electric will start a heavier load than the steam locomotive, for the reason that with the former the pull is constant through the entire revolution of the wheel, the difficulty of variation of pull with the angle of the crank in the steam locomotive being eliminated.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Lighting.

*27564. The Fire Risks of Electricity (J G L–Nov. 27.) 1700 w.

*27576. The Electricity Works at Bedford. Ill. (E E L–Nov. 30.) 5000 w.

27600. Electric Lights and Power in Boston's State House Extension (E R N Y–Dec. 12.) 400 w.

27708. Electric Lighting for Small Towns (T–Dec. 15.) 2200 w.

27808. The Louisville, Ky., Electric Light Company's Station Extension. (Ill. (E E N Y–Dec. 19.) 1000 w.

27816. Constitution of the Electric Arc. L. Thomas (Sc A S–Dec. 22.) 1000 w.

27842. Christmas and Electricity. Ill. (E W–Dec. 22.) 3000 w.

*27899. The Electricity Works at Cardiff. Ill. (E E L–Dec. 14.) 4500 w.

*27907. Electricity for Towns' Use: Where Shall It Be Generated? Walter J. May (Inv–Dec. 15.) 1000 w.

*27927. Dioptric Glass Shades. Ill. A. P. Trotter (E R L–Dec. 14.) 2500 w.

28162. The Making of the Incandescent Lamp. Ill. (E E N Y–Jan. 2.) 2800 w.

28271. Arc Light Carbons. B. F. Miles (E W–Jan. 5.) 2800 w.

28272. The Incandescent Lamp. Ill. Manning K. Eyre (E W–Jan. 5.) 6000 w.

*28310. Proposed Regulations for Electric Light Installations in Germany (E E L–Dec. 28.) 1400 w.

*28329. Industrial Lamps. Anon. (C G–Dec. 28.) 1200 w.

We supply copies of these articles. See introductory.

28360. The Frankfort, Germany, Municipal Electric Light Station. Ill. R. Haas (E E N Y-Jan. 9.) 2000 w.

Power.

*27461. Electric Power for Isolated Factories.—The Original Cost and Advantages. Ill. William A. Anthony (E Mag-Feb.) 3000 w.

*27509. The Direct Conversion of the Chemical Energy of Carbon into Electrical Energy. W. Borchers (El-Nov. 30.) 1800 w.

*27587. Alternating Current Motors. Rankin Kennedy (E R L-Nov. 30.) 800 w.

27654. Some Notes on Multiphase Power Transmission. Ralph D. Mershon (E W-Dec. 15.) 1500 w.

†27663. New Sources of Electric Power. I. Electric Energy Direct from the Coalfields. B. H. Thwaite. II. Electricity from Peat. J. Munro (N C-Dec.) 6000 w.

27702. The Power Transmission System at the King Powder Mills. Ill. (E I-Dec.) 700 w.

†27730. Discussion in New York on Paper by Samuel Reber—"The Theory of Two and Three-Phase Motors" (T A I E E-Dec.) 4200 w.

†27731. Discussion in New York of Mr. Steinmetz's Paper on "The Theory of the Synchronous Motor" (T A I E E-Dec.) 3300 w.

27860. Improvements in Storage Batteries. Maurice Barnett (E M J-Dec. 22.) 2400 w.

28023. Recent Electric Plowing Experiments in Germany. Ill. (E E N Y-Dec. 26.) 1000 w.

28124. The Electric Locomotives for the Baltimore Tunnel. Ill. (E R N Y-Jan. 2.) 700 w.

28273. Storage Batteries. Ill. J. Appleton (E W-Jan. 5.) 1800 w.

28274. A Central Station Dynamo. Ill. J. B. Cahoon (E W-Jan. 5.) 1800 w.

*28311. Some Possibilities of the Storage Battery. Pedro G. Salom, in Cassier's Magazine (E E L-Dec. 28.) 3800 w.

Telephony and Telegraphy.

27015. The Columbia Telephone System. Its Factory and Instruments. Ill. (Sc A-Nov. 24.) 800 w.

26956. A Resurrected Chapter in the History of the Invention of the Telegraphh. G. Wilfred Pearce (E N Y-Nov. 21.) 1700 w.

*27568. Experiments in Cable Signalling. Patrick B. Delany (El-Nov. 30.) 1000 w.

27660. Telephoning Minus a 'Phone.—Alleged Discovery of Walter Wilhelm (B J C-Dec. 15.) 800 w.

27781. Origin of Telegraphing Through Water Without Wires. Victor M. Berthold (E R N Y-Dec. 19.) 1500 w.

27782. A Telephone in His Hat.—Ingenious Device of a Chicago Lawyer to Get Evidence Directly to a Detective's Ear. Ill. (E R N Y-Dec. 19.) 600 w.

27810. Experimenting in Cable Signalling. Patrick B. Delany (E E N Y-Dec. 19. 1000 w.

27865. The Berliner Patent Void—Important Decision Against the Bell Telephone Company (E A-Dec. 23) 3000 w.

27910. The Cost of Telegraphic Blunders. R. D. Fisher (E N Y-Dec. 26.) 1400 w.

27911. The Telephone Question—The Effect of the Berliner Decision on the Industry (E R N Y-Dec. 26.) 5000 w.

27928. The Telephone Patent Situation. Ill. (E W-Dec. 29.) 1100 w.

28075. Electric Cables—Only Light Subaqueous Cables Manufactured in this Country (B J C-Dec. 29.) 1600 w.

*28315. Peculiar Telephone Troubles Caused by Alternating Current Distribution. E. W. Mix (El-Dec. 28.) 1300 w.

*28316. The Gilgit Telegraph Line (El-Dec. 28.) 1300 w.

*28320. Muirhead vs. The Commercial Cable Company. Editorial (E-Dec. 28.) 3800 w.

28361. The Callender Automatic Telephone Exchange System. Ill. (E E N Y-Jan. 9.) 4000 w.

Miscellany.

*26659. Modern Theories as to Electricity. What Is It? Whence Its Power? Henry A. Rowland (E Mag-Jan.) 3500 w.

26818. A Method of Distribution with Equalization of Potential Difference. D. H. Keeley, with Discussion (C Eng-Nov.) 5300 w.

*26942. The Electric Conductivity of Pure Water. J. W. Rodger (N-Nov. 8.) 1400 w.

*27468. Electricity Up to Date.—Electric Bells—Wiring and Connecting Up. Ill. (Iry-Oct.) 1300 w.

*27567. The Localization of Faults in High Tension Networks. F. C. Raphael (El-Nov. 30.) 1700 w.

*27570. On Villari's Critical Point in Nickel. Adolf Heydweiller (El-Nov. 30.) 1000 w.

27653. Electric Conversion System.—Devised by Ludwig Gutmann (W E-Dec. 15.) 1100 w.

27656. A Method of Determining Induction and Hysteresis Curves. Frank Holden (E W-Dec. 15.) 600 w.

*27693. Testing Practice in Electrical Engineering. Editorial (E R L-Dec. 7.) 800 w.

*27694. Dr. Borcher's Gas Battery: A suggestion. Legh S. Powell (E R L-Dec. 7.) 900 w.

27705. Electro-Plating Plants. Ill. H. G. Brownell (E I-Dec.) 1800 w.

27720. The Electric Problem with Reference to Fires and Firemen. G. P. Lowe (A G L J-Dec. 17.) 1500 w.

†27732. Discussion in Chicago of Elmer G. Willyoung's Paper on "Standardizing Electrical Measuring Instruments" (T A I E E-Dec.) 1300 w.

†27733. On the Production of Rotary Magnetic Fields by a Single Alternating Current. Ill. Ludwig Gutmann (T A I E E-Dec.) 4500 w.

*27759. I. Increase of Open-Circuit Loss in Transformers with Time. G. W. Partridge.

II. Note on Mr. Partridge's Paper. J. A. Ewing (El-Dec. 7.) 800 w.

*27760. Phenomenon Observed with Broken Magnets. Ill. (El-Dec. 7.) 1100 w.

†27792. An Apparatus for Exploring Magnetic Fields as to Direction and Intensity. Ill. W. E. Geyer (S In-Oct.) 2000 w.

27805. Locating a Bullet in the Human Body—Detecting Counterfeit Coins—Testing the Acuteness of Hearing. Ill. Nelson W. Perry (E N Y-Dec. 19.) 3000 w.

27809. The Manufacture of Chloride Accumulators. Ill. (E E N Y-Dec. 19.) 1800 w.

27843. A Practical Method for Measuring Rapid Changes in Current. Walter E. Harrington (E W-Dec. 22.) 700 w.

27931. Sparking of Closed Coil Dynamos. George T. Hanchett (E W-Dec. 29.) 1600 w.

*27977. The Life and Inventions of Thomas Alva Edison. Sylvanus P. Thompson (El-Dec. 14.) 3500 w.

*27978. Time Increase of the Open Circuit Loss in Transformers. J. A. Fleming (El-Dec. 14.) 1000 w.

28093.—75 cts. Non-Arcing Lightning Arresters. Ill. Alexander Jay Wurts (T Q-July.) 10000 w.

*28116. Experimental Investigations into the Origin of Frictional Electricity. C. Christiansen (E R L-Dec. 21.) 1800 w.

28160. Thermo Electricity—Detecting a Difference of Temperature of One Five-Thousandth of a Degree—The Bolometer and the Measurement of the Temperature of Starlight—One One-hundred-thousandth of a Degree of Temperature. Ill. Nelson W. Perry (E N Y-Jan. 2.) 3000 w.

28163. Shallenberger's New Alternating Current Meters and Indicators. Ill. (E E N Y-Jan. 2.) 1600 w.

28165. How Does Electricity Kill? F. A. La Roche (E E N Y-Jan. 2.) 1900 w.

28270. Reminiscences of By-Gone Electrical Days. Fred. A. Scheffler, in Cassier's Magazine (A G L J-Jan. 7.) 3400 w.

*28309. On the Effect of Magnetization upon the Dimensions of Iron Rings in Directions Perpendicular to the Magnetization, and upon the Volume of the Rings. Ill. Shelford Bidwell (E E L-Dec. 28.) 1200 w.

*28324. Accidents in Public Electric Supply Mains. Anon. (Eng L-Dec. 28.) 1400 w.

28362. What Constitutes Insurance? H. G. Tuckermann (E R N Y-Jan. 9.) 1500 w.

Serials.

9771. What Is Electricity? Sydney F. Walker (E E L-Began Jan. 6, 1893—7 parts to date—30 cts. each).

16631. The Scientific Study of Arc Lamps, Ill. Rankin Kennedy (E R L-Began Oct. 6, 1893—9 parts to date—30 cts. each).

22059. Practical Notes on Dynamo Calculation. Alfred E. Wiener (E W-Began May 19—23 parts to date—15 cts. each).

23866. Electrodynamic Machinery. Ill. Edwin J. Houston and A. E. Kennelly (E W-Began July 21—21 parts to date—15 cts. each).

24536. Principles of Dynamo Design. Newton Harrison (E A-Began Aug. 25—17 parts to date—15 cts. each).

25095. Postal Telegraphs. Ill. James Bell. (E L-Began Sept. 7—17 parts to date—30 cts. each).

25193. Electrical Machinist Practice. Ill. James F. Hobart (E E N Y-Began Sept. 19—16 parts to date—15 cts. each).

25895. The Design and Specification of Electric Lighting Works for Architects and Civil Engineers. Howard Pentland and Alfred H. Gibbings (E L-Began Oct. 5—13 parts to date—30 cts. each).

25897. The Velvo Battery with Mechanical Depolarization (E L-Began Oct. 5—Ended Nov. 30—2 parts—30 cts. each).

25907. The Alternating Current; Its Generation and Distribution. Ill. George D. Shepardson (E I-Began Oct.—3 parts to date—15 cts. each).

25954. Electric System of the Philadelphia Traction Company. Ill. Hermann S. Hering (E W-Began Oct. 20—Ended Nov. 10—4 parts—15 cts. each).

26592. Electrical Power Transmission. Ill. Louis Bell (E W-Began Nov. 10—7 parts to date—15 cts. each).

26945. Electricity on Board Ship and Its Application as Motive Power for Auxiliary Machinery. Alfred H. Gibbings (E L-Began Nov. 9—Ended Nov. 30—4 parts—30 cts. each).

27371. The Electric Light. Ill. Henry Stooke (I C B-Began Nov. 23—6 parts to date—30 cts. each).

27506. Suggestions in Preparing Specifications for the Electric Lighting of Buildings. Nelson W. Perry (E R-Began Dec. 8—2 parts to date—15 cts. each).

27599. Direct Current Motor and Dynamo Design. Ill. Gano S. Dunn (E N Y-Began Dec. 12—3 parts to date—15 cts. each).

27670. The Cologne Electric Lighting Station. Ill. (E-Began Dec. 7—Ended Dec. 21—2 parts—30 cts. each).

27704. Some Hints on the Building of Electric Plants. Charles G. Armstrong (E I-Began Dec.—1 part to date—15 cts).

27757. Induced and Impressed Electromotive Forces. Ill. (E L-Began Dec. 7—1 part to date—30 cts).

27804. The Commercial Possibilities of Accumulators for Tramcar Traction Considered as a Municipal Undertaking. Alfred H. Gibbings (E N Y-Began Dec. 19—Ended Dec. 22—2 parts—15 cts. each).

27855. Methods of Determining the Efficiency of Dynamos and Motors. J. Reginald Ashworth (E P-Began Dec.—1 part to date—30 cts).

27912. What Is Electricity? P. H. Vander Weyde (E R N Y-Began Dec. 26—1 part to date—15 cts).

INDUSTRIAL SOCIOLOGY

The Work of the Beer Money.

THE *Contemporary Review* has in a recent number a paper, entitled "The Work of the Beer Money," written by Mr. John Rae.

The selection of the title is explained in the first paragraph. "In the budget of 1890 Mr. Goschen put an additional sixpence of duty on the gallon of spirits, and set it apart, along with threepence a barrel of the existing duty on beer, as a subvention to local authorities to be devoted one-third, or nearly so, to providing pensions for the police, another third, or nearly so, to compensating publicans for the extinction of their licenses, and the residue to the reduction of their local rates. But the fund was no sooner created than the greater part of it was snatched from its original objects by a sudden gust of opinion and diverted to a more liberal destination.

"The representatives of the new technical education movement, headed by Mr. Arthur Acland, contrived to secure for county councils the option of applying the residue, if they so chose, to the promotion of technical education instead of the reduction of rates. Out of that option, originating in this almost accidental way, and conceded with probably little expectation of such a self-denying ordinance being actually exercised to any general extent, there has sprung up a movement of remarkable interest and activity in every county and borough of Great Britain; and the result is that more than four-fifths of the residue of the beer money (as this fund is popularly called, though much more of it comes from spirits than from beer), instead of going to the relief of the rate-payers, is now being spent by the representatives of the rate-payers themselves in furnishing the people with every variety of technical instruction."

We can now understand that the educational effect upon the English people of this expenditure of money raised by a tax on spirituous liquors is what is meant by "the work of the beer money," and that this has been important is made very evident before we read far. The economic proposition is made that "there is no better way of relieving rates than to enlarge the volume of wealth rated, and no better way of enlarging the volume of wealth rated than to increase the efficiency of the producers." After three years, in which the system has been undergoing probation, the status of the movement is as follows: About £1,350,000 is raised and divided,—80 per cent. to England, 11 per cent. to Scotland, and 9 per cent. to Ireland.

In Ireland the entire fund is devoted by statute to educational purposes. The Irish share is about £121,000, and of this sum about £78,000 goes to the national elementary schools, and the remainder to intermediate schools for payment of fees dependent upon the results of public examinations of students, payment of prizes, exhibitions, and giving of certificates to students. The residue is stated to have almost doubled the funds at the disposal of the Commissioners of Intermediate Education. The beneficial effect of this expenditure has been marked; but it is further stated that observation of the effect upon technical education in England has led to a movement for the establishment in Ireland of technical schools such as exist on the opposite side of the channel, where their success and usefulness are unquestionable.

"In England and Wales the residue the first year was £740,376, and of this £236,-242 was applied to the extinction of rates. Not more than £150,000 are now applied to that purpose, the remainder being applied to educational purposes. England and Wales, exclusive of London, last year received more than £600,000 of the beer money, and only appropriated £35,000 to rate-payers' relief, leaving the handsome sum of over half a million pounds for

educational purposes." Of this remarkable fact Mr. Rae says:

"When we think that there are more than one hundred and twenty counties and county-boroughs in England and Wales, the unanimity with which they denied themselves the relief a benevolent Chancellor devised for them, and spent the money instead upon the new excitement of technical education, is really surprising. No county or county-borough in England and Wales now applies the whole of the beer money, and only eleven apply any part of it, to the reduction of their local burdens."

The successful results of the use of the fund for fostering technical schools in England are very elaborately stated.

Outlook for Western Farmers.

HON. L. D. LEWELLING, governor of Kansas, in "Problems Before the Western Farmer" (*The North American Review* for January), takes a gloomy view of the agricultural situation in the West. He regards the status of the agricultural interests in Kansas as "probably similar to that of other Western States," and, on the conditions therein existing, he bases remarks thought to be generally applicable to prevailing conditions in the entire section. The farm mortgage debt of Kansas, as shown by the census of 1890, aggregates $167,145,039, and, when to this is added the real estate mortgage debt on lots, municipal, county, and school-district debts, railroad indebtedness, State bonds, and chattel mortgage indebtedness, the sum divided by the entire population gives the quotient, five hundred dollars, of indebtedness "for every man, woman, and child in the Commonwealth."

"It is said with much truth that the entire burden of debt hanging over the Western and Southern States must be paid by the agricultural class. And yet in Kansas more than ten thousand persons of this class are annually dispossessed of their homes in consequence of the foreclosure of mortgages, and the number is probably increasing rather than diminishing. Interest grows by day and by night, through the wet season and the dry, while land values decline and the price of products steadily depreciates; and the end is not yet. . . . Twenty-five to twenty-eight years ago, with one bale of cotton, a Southern farmer could buy nearly five hundred dollars, and with one sack of wheat (two bushels) a Northern farmer could buy five dollars. Now it requires seventeen bales of cotton and more than six sacks of wheat to bring these respective amounts. What is true of cotton and wheat is also true of other products of the farm. A few years ago an average horse would have been regarded as sufficient security for fifty to seventy-five dollars; but to-day it would require eight horses of the same kind to secure an equal amount. The farm which was regarded as ample security for fifteen hundred dollars is in many instances now sold for the mortgage, or perhaps less. And thus well-to-do farmers are being gradually forced into bankruptcy. Throughout the West, men who would borrow money find it impossible to offer security."

After these statements, what shall we think of the picture of content among the agricultural masses to which we were treated by Octave Thanet in the October number of *The Forum*? A condition of hopeless indebtedness verging on bankruptcy is not usually one of sweet content; and, when farmers are selling at forty cents a bushel wheat that costs fifty cents to produce, it seems almost mendacity to assert that they are contented. On the contrary, listen to this: "To comprehend the condition of the Western farmers, it must be understood that they are largely a debtor class, and they feel that in the gradual shrinkage of values they have been wronged. They also believe legislation to be responsible for the shrinkage, and look to legislation for a remedy." This is not the voice of contentment. It is a voice that is more and more making itself heard, and its complaining is a full, clear explanation of the trend of political events in Kansas and other Western States. "With even moderate returns for their products the farmers would have been satisfied; but with the low prices, each year tending lower, interest and taxes became more burdensome, and attention was called to

the enormous amount of money each year forwarded to the Eastern mortgage-holder. It was argued that the total increase of wealth in the United States since the foundation of the government had not exceeded three per cent. per annum, and yet the Western farmers were compelled to pay tribute to money-lenders of six, eight, ten, and even twelve per cent. per annum, and were thus speedily drawing forward toward bankruptcy. The conditions were emphasized in Kansas by pointing to the ten thousand farm people made homeless every year by mortgage foreclosures, who, being thus deprived of their homes, were made dependent on their labor for support, and thus swelled the great army of unemployed. This, indeed, was the bond of sympathy everywhere between the farmer and laborer, and may account in some measure for the lively sympathy manifested by the farmers for striking laborers and the so-called industrial army. Each argued that he, himself, might soon become one of the homeless and unemployed. And this is one reason why partisan feeling became so intense among Populists."

Here is exposed the secret of the support given to Coxey's army on its way to Washington, and in this sympathetic feeling is shown the origin of the Farmers' Alliance and of the Populist Party, the doctrines of which were promulgated "with a sort of politico-religious enthusiasm seldom witnessed in political campaigns." The Western farmer believes "the prime cause of all his woes is the manipulation of the money system of the country by unscrupulous and mercenary interests." Whether he is right or wrong in this conclusion, he is a force to be dealt with,—a force which cannot be ignored by those whose hands are to shape the destinies of the country.

Convicts on Public Roads.

THE policy of the utilization of convict labor for the public benefit is an ancient one. Until society has learned to eliminate crime and criminals, and relieve itself from the maintenance of prisons and other penal institutions, the problem of how to punish criminals with least cost to the State will be studied with reference to the most economical way in which punishment can be united with labor without at the same time disturbing the general current of industry. Recently there has arisen strenuous opposition to the employment of convict labor in manufacturing industries, by which more or less competition is created between prison labor and free labor, and the tendency of opinion in some quarters now appears to be toward the employment of prison labor in occupations requiring labor pure and simple rather than skill.

On the other hand, there is a large number of people who regard the reform of criminals as the chief end of punishment, and who reason that, if criminals during confinement can be taught some trade or occupation which can be practised after their release, they will be less likely to fall back into crime. There is room for argument on both sides of this question, and recent labor disturbances growing out of the employment of convict labor, especially in mines, have strongly impressed the public mind with the belief that the subject demands careful reconsideration. Many able thinkers regard the good of society as the sole excuse for human punishment, and believe that, as the criminal has forfeited his social rights by misconduct, the treatment he should receive should be determined from the standpoint of public welfare, and that his individual welfare should be entirely subordinated to this. Others, looking upon crime as an effect of moral disease, defective education, etc., regard criminals rather as victims of misfortune, to be pitied rather than severely punished, and the humanity of this view is well calculated to win the support of a large class of sympathetic people.

Prof. Holmes, State geologist of North Carolina, is the author of an article in the *Manufacturers' Record* (Nov. 16) which gives the workings of the system of applying convict labor to the improvement of public highways in that State, and evidently regards this as at least a partial solution of the problem of good roads, as well as that of making criminals compen-

sate in some measure by public service for the public injury they have committed.

"In a few of the counties the experiment has been in progress for more than a decade; in others it has been started within the past year, and it now seems probable that more than a dozen additional counties will adopt this system during the next twelve months. So that it will be seen that the system is growing in favor, and of the counties which have already adopted it not a single one will at the present day listen to a proposition to abolish it.

"In a few cases this plan has been adopted by the township, and in such cases the entire management of the convict force and of the work which they do is under the control of the township board of supervisors or magistrates. When it is a county measure, this control is in the hands of the commissioners. And in both cases a supervisor or superintendent of the convict force is employed, who has charge of the details of the work, and who employs a sufficient number of guards to prevent the escape of the convicts.

"A system styled 'unique' is used in Lenoir county, N. C. All long-term or 'dangerous' convicts from this county are sent to the State penitentiary. A dozen or more of the short-term convicts have been employed on the roads for the past year, and with most satisfactory results, at a cost not exceeding fifteen cents a day per convict for food and clothes. No guards have been employed. One superintendent or foreman has managed the squad unarmed. Each convict in the beginning has been photographed and carefully described, and has been notified that, if he attempted to escape, he would sooner or later be caught and punished, but that, if he remained at his post and worked faithfully, at the end of his term he would be given a reward. As a result of this treatment, although these convicts have been allowed the privilege of staying with their families from Saturday night to Monday morning, not a man has attempted to escape, or has failed to report for duty on Monday mornings or at any other time."

On the whole, the results of this sort of employment for convicts seem favorable, but it is pointed out as "an important fact to be kept in mind" that in all prisons there are some who cannot endure severe labor, and some who are so desperate and dangerous "that they must be allowed no shadow of a chance to escape." This brings us back to the problem of the kind of work that should be supplied to prisoners who must be held in confinement; so that road improvement is not such a complete and final solution as at first it might appear. At least the long-term, able-bodied, and dangerous criminals ought to be made to work enough to support themselves, without expense to the State, and, if their labor can be made to more than pay their keep, this excess may well be retained by the State as in the nature of a fine, and as part of their punishment.

The Labor Church.

ONE of the phases of industrial sociology destined to a place in the history of our times is the religious phase. When Dr. McGlynn expounded the doctrine that the Roman Church is emphatically the church of the poor, and that, because poverty has come upon the laboring classes, the great influence of the most powerful hierarchy in the world should be exerted on the side of the struggling and suffering masses, he indicated clearly the possible identification of the material interests of labor with the religion of the poverty-stricken masses whose cause he has wisely or unwisely espoused. The Salvation Army has been another indication of this possibility; and in the so-called "Labor Church," the first service of which was held in Manchester, England, on the afternoon of Sunday, October 4, 1891, the possibility became a fact. An account of this movement, "The Labor Church: Religion of the Labor Movement," by Mr. Trevor, is given in *The Forum* for January. Among the personal sketches of its writers for the month, that of Mr. Trevor follows:

"Mr. John Trevor, born in Liverpool, England, 1855, was educated at Wisbeach, Cambridgeshire, and afterwards became an architect. In 1877 he visited Australia and

later the United States, where he spent a year at the Meadville (Pa.) Theological School. He then returned to England, and, after a year at Manchester New College, became assistant-minister to Philip Wicksteed at the little Portland-street Chapel in London. In 1890 he returned to Manchester, and with the help of friends founded the Labor Church. Mr. Trevor edits the *Labor Prophet*, and he has published two pamphlets, Theology and the Slums; and Man's Cry for God."

A considerable part of Mr. Trevor's paper is devoted to his personal evolution into a "Labor Prophet," though he has appropriated this title only for the publication he edits. Passing over this part, we come to the formulated principles or creed of the Labor Church.

"1. That the labor movement is a religious movement. 2. That the religion of the labor movement is not a class religion, but unites members of all classes in working for the abolition of commercial slavery. 3. That the religion of the labor movement is not sectarian or dogmatic, but free religion, leaving each man free to develop his own relations with the power that brought him into being. 4. That the emancipation of labor can only be realized so far as men learn both the economic and moral laws of God, and heartily endeavor to obey them. 5. That the development of personal character and the improvement of social conditions are both essential to man's emancipation from moral and social bondage."

The *Labor Prophet* is the organ of the movement, and is sold at one penny per copy. "A Labor-Church hymn-book followed, and more recently a tune-book has been issued. Labor-Church tracts have also been published, and many thousands of handbills explaining our aims and principles. In July, 1892, a Labor Church was opened at Bradford, and others soon followed. In every case the demand for a church has been entirely local and spontaneous. In July, 1893, the first conference of Labor-Church delegates was held in Manchester, a Labor-Church Union was formed, a constitution adopted, and a council appointed to carry forward the work of the movement. Fred Brocklehurst, who had formerly assisted me in the work, was appointed general secretary to the union. Mr. Brocklehurst had studied at Cambridge with a view to entering the Church of England, but, immediately upon taking his academic degree, he threw himself wholly into the Labor-Church movement.

"At the time of the conference in 1893, there were fourteen churches; there are now twenty-four. In connection with several of the churches adult classes are held, libraries have been formed, and very poor children are fed and entertained in the winter and taken into the country in the summer. The publication of the hymn book and the tune-book has enabled them to develop very hearty and characteristic singing. Solos, glees, and anthems often form part of the service. Social gatherings are frequently held on Saturday evenings in the winter. At the present moment we are going forward with the formation of Sunday schools."

Mr. Trevor thinks the Labor Church is destined to become international, basing this opinion upon the fact that it has already migrated to America and taken root in Lynn, Mass., and Providence, R. I. It presents the curious spectacle that its preachers are, so far, admittedly "politicians first and foremost." The movement is unique in some of its features, but is of a kind that may draw to it many followers. The effect of religious enthusiasm upon social upheavals has been often demonstrated in history, and many instances will readily recur to well-informed persons. This experiment of combining politics with religion may develop some curious sociological reactions before it is ended.

The Nature of Political Authority.

To Prof. R. T. Ely's article in the October number of *The Forum*, noticed in this department of our November number, the strongest reply yet seen is editorially made in a scientific periodical. In this article Prof. Ely is charged with "the confusion of a simple matter by the introduction of what Auguste Comte would have called 'metaphysical considerations.' Prof.

Ely raised the following questions, which the editor of *The Popular Science Monthly* (Dec.) quotes and comments upon.

"'What is the source and sanction of the authority of the State?' Is the State, he goes on to ask, 'a mere aggregation of individuals, accomplishing their purpose simply by brute force? Does might make right? If it does, then is not the question between Anarchy and its opponents simply a question of superior force? But if it does not make right, what does make right? Has the State an ethical nature? If the State is itself non-ethical, can the power which it exercises have an ethical element? But if it is devoid of an ethical element, can it rest upon anything less than mere brute force?' This is rather a long string of questions, and the professor tells us that he will not attempt to answer them; but he observes that, if the State is a divine institution and derives its authority from God, 'then we have a ground of opposition to Anarchy.' Otherwise—he evidently means us to infer—our ground is very weak."

To the question, "Is the State a mere aggregation of individuals, accomplishing their purpose by brute force?" it is answered: "No, the State is an aggregate of individuals whose views in regard to what is a desirable constitution of society are in the main harmonious, and who have no occasion to use brute force except upon a certain limited number of stupid offenders against laws which, in their general operation, make for the good of the community as a whole. 'Does might make right?' Answer: No, might does not make right, but it is an excellent thing for giving effect to what the upholders of social order believe to be right. 'If it does, then is not the question between Anarchy and its opponents simply a question of superior force?' Answer: No, for if might makes right (which is the hypothesis), then right as well as might is on the side of the State. 'But if might does not make right, what does make right?' Answer: The only way to 'make right' is to do right actions. Right is something that can never be more than approximately attained; but we hold that social order is right because it secures, or at least makes possible, the happiness of the great majority of human beings, and deprives none of happiness save those whose happiness involves unhappiness to others."

If an ethical character be ascribed to the State, it is argued that this could only "find expression in the action of individuals." As to the State being a divine institution, the answer is that it "derives its authority from God just as much as and no more than the New York Central Railway, or any other corporation, down to a village baseball club. It may be under righteous or unrighteous control; so may the railway, so may the baseball club. When it enacts dishonest and oppressive tariff laws, it is just as well not to lay too much stress upon its divine mandate. On the other hand, when it enacts an honest law for the good of all; when it faithfully carries out its obligations, national or international; when it upholds justice between man and man,—we set the seal of our moral approval on its action, but we do not ascribe any special authority to that action on the ground that 'the State is a divine institution.' We feel instinctively that nothing can be more divine than justice, and, when the State succeeds in being just, we simply rejoice that it has been able to approximate to our conception of the divine. The State, in fact, does not, so far as this goes, differ in any respect from the humblest individual citizen who has it in his power to do right or wrong, to place himself in harmony with or in opposition to what he feels to be the will of God." This seems a "facer" for Prof. Ely.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

25590. The Liability of Labor Unions for Damages—The Lucke Case. R. W. Raymond (E M J-Sept. 29.) 500 w.

25618. Governor McKinley Compares the New and the Old Tariff Laws (B I S-Oct. 23.) 1500 w.

We supply copies of these articles. See introductory.

25591. Bimetallism vs. Silver Monometallism (E M J-Sept. 29.) 1500 w.

†25963. The Work of the Beer Money. John Rae (C R-Oct.) 12000 w.

26849. Convicts on the Public Roads. Professor Holmes Gives the Workings of this System in North Carolina (M R-Nov. 16.) 3000 w.

†27412. The Nature of Political Authority. Editorial (P S M-Dec.) 1200 w.

*27454. The Causes for Prevailing Low Prices—Supply and Demand a Universal Law. Albert Williams, Jr. (E Mag-Feb.) 3000 w.

*27541. Advances to Farmers.—A Practical Suggestion (B M-Dec.) 1600 w.

*27542. Mr. Shaw Lefevre on the Fall in Prices (B M-Dec.) 3000 w.

*27561. The Labor Department of the Board of Trade (Tr-Nov. 30.) 1200 w.

27562. Lord Farrer on Statistical Science (J G L-Nov. 27.) 2200 w.

†27585. Hours, Labor and Wages (I E-Nov. 3.) 1200 w.

27647.—75 cts. The Nature of Sociology. Bernard Moses (J P E-Dec.) 5000 w.

27648.—75 cts. Adequacy of the Customs Revenue System. Robert F. Hoxie (J P E-Dec.) 11300 w.

†27664. How to Multiply Small Holdings. Lord Carrington and Harold E. Moore (N C-Dec.) 5800 w.

†27665. The Cry Against Home Work. Ada Heatner-Bigg (N C-Dec.) 7000 w.

27711. Currency and Its Reform (E M J-Dec. 15.) 3000 w.

*27780. Federation and Some of its Attendant Advantages (B M A-Nov.) 9000 w.

28856. Gold Exports and Currency Reform (E M J-Dec. 22.) 1200 w.

27861. A Co-operative Foundry Enterprise. Ill. J. T. Bramhall (F D-Dec.) 1100 w.

27862. The Mission of Trade Unions. Martin Fox (F D-Dec) 1000 w.

27940.—$1. Money and Bank Credits in the United States. Henry W. Williams (An A A-Jan.) 9000 w.

27941.—$1. How to Save Bimetalism. Duc de Noailles (An A A-Jan.) 4000 w.

27942.—$1. Trusts: Abuses and Remedies. Jerome Dowd (An A A-Jan) 2000 w.

27943.—$1. The Relation of Economics to Sociology. Simon N. Patten (An A A-Jan) 3300 w.

*27962. Intercolonial Trade and Communication. Editorial (E-Dec. 14) 2000 w.

*28003. Our Dwindling Trade with the East. Jeremiah Head, with Editorial (I C T-Dec. 14.) 3800 w.

28050. Symposium in the Currency. I. Why Government Notes Are a Bad Currency. Van Buren Denslow. II. Reply: Why the Creation of Money Is the Primary and Paramount Duty of Government. Henry Carey Baird (S Ec-Jan.) 4200 w.

*28051. An Argument for the Single Tax. Isaac Feinberg (A M C-Jan.) 4000 w.

*28052. Gold and Silver Both. H. A. Scomp (A M C-Jan.) 4000 w.

*28053. What Ails Unskilled Labor in America? P. Vedel (A M C-Jan.) 3700 w.

*28054. Some of the Dangers of Free Coinage. Arthur B. Dale (A M C-Jan.) 2000 w.

*28055. An International Paper Currency. John F. Hume (A M C-Jan.) 2900 w.

28080. Better Prevent than Settle Strikes. Editorial (A M & I W-Dec. 28.) 700 w.

†28084. The Coming Industrial Order. James G. Clark (A-Jan.) 5200 w.

†28085. The Sweating System in Philadelphia. Frank M. Goodchild (A-Jan.) 2200 w.

†28087. Our Trade with China. Worthington C. Ford (N A R-Jan.) 3600 w.

*28091. The Industrial Christian Alliance of New York. Arthur W. Milbury (R of R-Jan.) 4500 w.

*28104. The End of a Trade Union.—The National Amalgamated Sailors' and Firemen's Union. Editorial (Eng L-Dec. 21.) 1600 w.

†28159. Problems before the Western Farmer. L. D. Lewelling (N A R-Jan.) 1800 w.

28171. The Insurrection of June and July, 1894. (Extract.) Joseph Nimmo, Jr. (R R-Dec. 29.) 2500 w.

*28222. The Humiliating Report of the Strike Commission. H. P. Robinson (F-Jan.) 3800 w.

*28223. Grave Danger in Our Presidential Election System. James Schouler (F-Jan.) 2000 w.

*28224. Is the Existing Income Tax Unconstitutional? David A. Wells (F-Jan.) 1700 w.

*28225. The Anatomy of a Tenement Street. Alvan F. Sanborn (F-Jan.) 8000 w.

*28226. The Crux of the Money Controversy: Has Gold Risen? Louis A. Garnett (F-Jan.) 2800 w.

*28227. The Labor Church: Religion of the Labor Movement. J. Trevor (F-Jan.) 2200 w.

*28228. A New Aid to Popular Education: Free Travelling Libraries. William R. Eastman (F-Jan.) 2500 w.

*28229. The Increasing Cost of Collegiate Education. C. F. Thwing (F-Jan.) 2500 w.

*28230. The Financial Year and the Outlook. Anon (F-Jan) 2000 w.

28237. Labor as an Element in Southern Manufactures. William M. Stewart (T-Jan. 1.) 2000 w.

28238. Comparative Study of Southern Labor. J. B. Killebrew (T-Jan. 1.) 2500 w.

28239. The Importance of the Nicaragua Canal to the South. Ill. Warner Miller (T-Jan. 1.) 1800 w.

28241. The Industrial Future of the South. Clark Howell (T-Jan. 1.) 800 w.

28307. The Nicaragua Canal. S. Waterhouse (A S-Jan. 5.) 4000 w.

We supply copies of these articles. See introductory.

MARINE ENGINEERING

Administration of the British Navy.

THE placing of men in positions for which they are unfit is something which frequently happens in the administration of public affairs. Social and political influence overshadow merit, and the "Tite Barnacles" get their innings with accompaniments of fat salaries and perquisites, while sterling worth and real ability go into retirement, or, if in office, are repressed in interests of political rings. The people of the United States have seen so much maladministration that sometimes, in discouragement, they think we must be worse than other nations, and wonder why it is so.

Some of the comfort which is said to be afforded to the miserable by the knowledge that others suffer also may be derived from an editorial in *Engineering* (London, Dec. 7). Discussing the paper on "The Machinery of Warships' read before the Institution of Civil Engineers (Nov. 20), it finds it a mass of "dry bones," affording only unsatisfactory pickings; and among the reasons assigned for such a paper from so able an engineer as Mr. Durston is found the crumb of comfort above mentioned.

"The paper itself was confessedly incomplete, but it was as complete as our political organization allowed us to expect it to be. Every one knows that Mr. Durston could, if he were permitted, write a really good and instructive paper on 'The Machinery of Warships,' instead of putting together a record of bare dimensions and bald details of performance. We know that the engineer-in-chief, and those associated with him, have very decided views on some points connected with the practice of machinery design; and, indeed, they would be altogether unworthy of their positions were it not so. Why, then, is the Institution served with a paper so inadequate to the oecasion? The answer is not far to seek. The engineer-in-chief is an official in the department of the controller of the navy, and is entirely subordinate to the controller. That is a matter of routine. The controller of the navy is an executive officer of high attainments, a rear-admiral whose professional instincts and training do not put him in sympathy with engineers. The traditions of his caste all tend toward exclusiveness and secrecy, and the traditions of the department into which he has been brought support this attitude. But, even if the controller of the navy were a man of the widest views, he is not master of his own actions. He holds office for a short period,—so short that he has not time to learn his duties before he has to go. The consequence is that he is very much in the hands of the clerks,—a class without the high, even if unenlightened, sense of duty towards the service which is the main spring of the naval officer's conduct. Neither have they the scientific interest which animates the professional officials. There is, however, another check on our ideal liberal-minded controller,—the political element, which is paramount. No ordinarily intelligent newspaper-reader need be told how little account an engineering department of the navy is in the eyes of the average parliamentarian. The whole mystery of party politics is to lie low whilst in office, and trip your enemy's heels when out."

This state of things is regarded as cause for apprehension. What may be expected to happen in the case of a serious naval war is pointed out. "The highly trained professional officials at Whitehall are unable to do themselves justice before the public, or to expose their work to the healthy criticism and discussion which would so much strengthen their hands, increase their knowledge, and give them a wider interest in their labors. No class suffers more from the absurd secrecy of the department than the constructors and engineers of the admiralty staff. Some day, perhaps, we will have a serious naval war. Then the country will learn this ill-assorted triumvirate of government clerk, parliamentarian, and executive officer is

not the right instrument with which to mould and direct a great engineering organization. We shall learn it at the expense of many valuable lives and the loss of much inestimable treasure,—probably at the cost of a serious military disaster."

It is charged that the treatment of contractors by the admiralty has recently been very bad, and that makers of navy engines have thereby become thoroughly dispirited. One firm is cited as having lost ten thousand pounds on a contract for their ships; others have suffered in a similar manner, and their losses are referable to waste and mismanagement on the part of the admiralty.

The Colomes Leak-Arrester for Ships.

IN the spring of 1894 tests of the Colomès leak-arrester were made before a board appointed by the United States navy department, and in the presence of several naval officers, Mr. Lewis Nixon, a well-known naval constructor, and Capt. Constance, naval attaché of the British Legation in Washington. The tests were made with tanks, in the sides of which holes, analogous to those made by rocks or projectiles in the bottoms and sides of ships, were formed, the tanks being kept filled to a certain height by pumps during the performance of the experiments, which consisted in stopping the holes in the tanks on the outside in the same manner as they would be stopped at sea on the inside of the vessel.

The vital features of the system consist in the material employed, the simple mechanical means for making the required application of this substance to the leak, and the also extremely simple manipulation which, performed in from thirty seconds to three minutes, either completely stops the leak, or, in the few cases where the irregularity of the opening prevents absolute stoppage, so far obstructs inflow as to obviate any danger therefrom.

The material relied upon for stopping leaks is cellulose, a substance that greatly increases in bulk by the absorption of water. Figures 1 and 2 respectively illustrate a hole to be stopped and the apparatus applied to the same opening, and stopping it. *The Iron Age* (Jan. 3) gives a description of the apparatus and an account of the tests above mentioned. It is stated that the system, after trial, has been adopted by the French government.

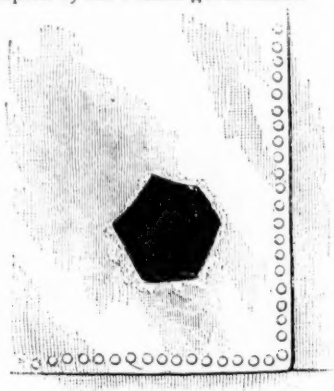


FIG. 1.—SHAPE OF HOLE.

"The apparatus for applying the cellulose to the hole is extremely simple. It is composed of a steel rod, threaded on a part of its length, at the end of which is pivoted

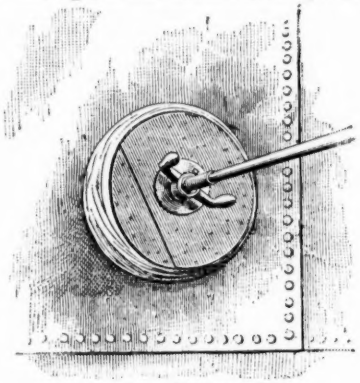


FIG. 2.—HOLE STOPPED.

an iron piece, which, when at right angles to the rod, has the appearance of a pickaxe, one of the arms of this cross-piece being heavier than the other. This cross-piece has fixed to it an oval piece of flat iron covered with thick felt. A small conical bag, filled with cellulose, and having a hole through its center, can be slid onto the rod. Back of this bag is applied a large washer, which is held in place against the

bag, as shown in Figure 2, by a nut which is pushed down the rod to the threaded part, where it engages the screw. When a leak has been located, any man can seize a leak stopper corresponding approximately in size to the width of the hole. Then, holding it with the lighter end of the pick toward him, so that the pick and oval plate lie alongside the rod, he can introduce it into the hole. He can avoid the rush of the water by standing to one side. As soon as the pick has passed through the plating, the heavier end descends, and the pick places itself across the hole, while the pressure of the outside water forces it against the side of the vessel and throws the pick arm across the opening; so, resting on the plating around the hole, it affords a point of support, while the felt-covered plate reduces the leak very much and makes easier the next operation, which consists in slipping the bag of cellulose, washer, and nut over the rod, screwing down the nut till the bag of cellulose is compressed against the hole. The cellulose bag fills up all parts of the hole, no matter how irregular, as the great value of the cellulose consists in its absorbing water and greatly increasing its volume. This elastic mass makes a tightly-applied mat over the hole, which cannot be accidentally disturbed or displaced. Should the hole not be more than ten inches wide and several feet long, a number of leak-stoppers can be used side by side, so as to gradually fill the hole. For holes of much larger area Mr. Colomès proposes to use a cellulose mat to be applied from the outside of the vessel. This mat resembles an ordinary mattress filled with obturating cellulose, and is made in several sizes. The side of the mat away from the side next to the ship is covered with water-proof cloth, in order to prevent too much water from filtering through the cellulose. On the sides and at the corners rings are fixed, intended to receive guiding ropes. Such ropes should always be kept in readiness on the upper deck, bent and with the slack so arranged that they will fall under the vessel so as to hang from gunwale to gunwale. These ropes are to receive the mats as soon as a leak is discovered and located. The soft, pliant nature of the cellulose lining of the mat enables the pressure of the water to force it into all parts of the opening, so that every crack is filled and the inflow automatically stopped." In the experimental tests referred to, against a head of twelve feet, a 2½ inch-hole was stopped in thirty seconds, a 10-inch hole in three minutes, a 21-inch hole in thirty-seven seconds, and a 21-inch hole in one minute and forty seconds.

Water-Tube Boilers for Marine Use.

IN a paper read before the Wissenschaften Varien der k. und k. Kriegsmarine, which has been translated and is now appearing serially in *The American Engineer and Railroad Journal*, the first number of the series contains a comprehensive classification of water-tube boilers, and gives promise of an attempt to treat the subject thoroughly. Four groups of types are taken as including all the water-tube boilers that have yet appeared. While, in respect of types, this classification may be accepted without demur, the boilers named as included in the different classes do not comprise all that have gone into extensive use, some of the more important—for instance, the Sterling and the Heine—not being mentioned. Possibly the placing of the Babcock and Wilcox boiler in the class of those with bent tubes is an inadvertence. The classification follows:

"(a) Water-tube boilers with straight and level tubes. This group comprises the Perkins, Belleville, Palmer, and Herreshoff boilers. (b) Water-tube boilers with straight and inclined tubes. These are the Root, Watt, Belleville, Yarrow, Oriolle, Lagrafel, d'Allest, Sampson, Durr, and Niclausse boilers. (c) Water-tube boilers with bent tubes. Of such are the first Belleville boilers, the Rowan, Ward, Du Temple, Normand, Thornycroft, Yarrow, Babcock & Wilcox, Wilson, and Gleming & Furguson boilers. (d) Water-tube boilers with spiral tubes. These include the Herreshoff, Hohenstein, Bellis, and White boilers."

The circulation in water-tube boilers, which is one of the most important principles in their action, is illustrated by Fig-

ures 1, 2, and 3. "As the water contained in the tubes is heated, it rises into the space above, causing a circulation in the boiler. While the warm and specifically lighter water rises into the water space above, an equal amount of cooler and specifically heavier water descends.

"Such a circulation is shown in Figure 1, where the heated water rises at *B*, while the cooler water flows back through *C*.

"The form of boiler given in Figure 3 shows that, if the sectional area of the tubes at *A* is sufficient for the circulation of the water, then that at *B*, where a higher temperature exists, will be insufficient. The result is that the tubes are overheated, and this has actually occurred in many miscalculated water-tube boilers. On the other hand, it is a further requirement from the standpoint of safety that

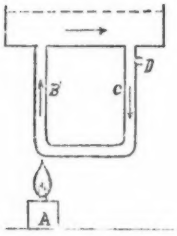


FIG. 1.

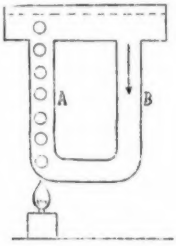


FIG 2.

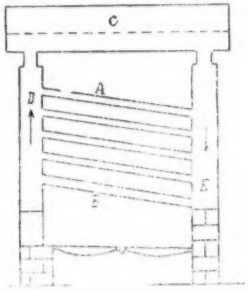


FIG. 3.

The rapidity of the circulation can be increased by introducing the feed-water at *D*. The case often occurs that the water in one part is lighter, because it is a mixture of steam and water, as represented by Figure 2, and the hydrostatic law seems at fault, for it is independent of the hydrostatic pressure on the cross-section: so the circulation of the water will be maintained by the generation and the movement of the steam.

"A strong and regular circulation of the water is an essential feature for the proper action of water-tube boilers. It protects the tubes which are subjected to high temperatures from burning; it equalizes the temperature and the expansion of the whole boiler structure; and the result is that the generation of steam is raised to the highest possible point. The circulation of the water ought not to be injured through the choice of the sectional area of the tubes. The higher the temperature and the greater the corresponding length of the tubes, just so much the larger must the cross-section of the same be made; otherwise the tube, on account of an insufficient circulation of water, will only deliver a stream of steam.

the sectional area of the tube should not exceed a certain amount, in order that the average tube can be run to advantage. It is upon these grounds that the diameters of water tubes for the different types of boilers used on vessels of war vary between the wide limits of 1 in. and 4 in., while the boilers for vessels engaged in commerce are usually fitted with tubes of the larger sizes."

The extent to which water-tube boilers have gone into use for marine purposes is also indicated. In 1879 the French despatch-boat, Le Voltigeur, was fitted with the Belleville boilers, and up to the present time the French admiralty has applied the boiler "to vessels of all sizes and kinds." Eighteen French ships, varying from 400 to 14,000 I. H. P., seven Russian vessels, varying from 200 to 15,000 I. H. P., and three English ships varying from 3,500 to 25,000 I. H. P., are named as being furnished with power by the Belleville boiler, these all belonging to the navies of the countries mentioned. A considerable number of vessels in the merchant marine are also enumerated as using Lagrafel, Babcock & Wilcox, and other kinds of water-tube boilers.

Sanitation of Ships.

AT the recent congress of the Sanitary Institute in Liverpool, Sir William Forwood made some remarks on this subject which the *Scientific American Supplement* (Dec. 8) has printed. The council of the sanitary congress decided that special attention should be directed to the consideration of sanitation in ships, and the address was for the purpose of bringing the subject before the section devoted to the subject, over which section Sir William Forwood presided. He asserted that a discussion of the past and present status of sanitation in ships would be welcome to Liverpool ship-owners, who had "always been in the forefront in the adoption of every improvement likely to promote the health and comfort of the people in their employ."

The three great essentials in sanitation —good air, good drainage, and pure water —can easily be obtained at sea, and on this account, perhaps, it might be thought that a discussion of the sanitation of ships is unnecessary. But the condition of ships, especially in the forecastle, was, not many years ago, "a disgrace to our civilization." Much improvement has been made, but there is yet room for reform. What has already been accomplished is very praiseworthy and encouraging, as is shown by a contrast of past with present conditions.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

*27463. The Great Steamboats of the Hudson River.—The Evolution from the Earliest Types. Ill. Samuel Ward Stanton (E Mag-Feb.) 3000 w.

*27527. The Commercial Speed of Steamers. (Abstract.) J. Denholm Young (S L-Dec.) 2000 w.

*27528. Consideration on the Battleship in Action. William Laird Clowes (S L-Dec.) 2400 w.

*27553. Engineering in the United States Navy. Editorial (E-Nov. 30.) 1700 w.

*27560. A Glance at the German Ports (Tr-Nov. 30) 2200 w.

27632. The Future of Our Shipping.—Discriminating Duties the Best Remedy. Richard P. Joy (Sea-Dec. 13.) 1000 w.

*27672. The Machinery of Warships. Editorial (E-Dec. 7.) 2400 w.

*27673. Electricity on Shipboard. Editorial (E-Dec. 7.) 900 w.

*27945. Proposed Government Shipbuilding Yard at Lisbon (B T J-Dec.) 1800 w.

*27966. The Chilian Cruiser Blanco Encalada. Ill. (Eng L-Dec. 14.) 7400 w.

*27970. The Machinery of War Ships. Editorial (Eng L-Dec. 14.) 2400 w.

*28004. The Commerce and Shipping of the Great Lakes (Tr-Dec. 14.) 2000 w.

28026. The Cramp Ship Yard. Ill (Sc A-Dec. 29.) 1500 w.

†28088. Shall We Have Free Ships? Edward Kemble (N A R-Jan.) 4000 w.

*28099. H. M. S. "Magnificent." Editorial (E-Dec. 21.) 3000 w.

28156. The Calomès Leak Arrester for Ships. Ill. (Ir Age-Jan. 3.) 000 w.

28283. Repairing a Broken Valve Chest on the Concord. Ill. Harold P. Norton (Eng-Jan. 5.) 900 w.

28296. Sanitation of Ships. (Extract.) William Forwood (Sc A S-Dec. 8.) 900 w.

*28319. Triple Screws. Editorial (E-Dec. 28.) 2500 w.

*28322. The Luminous Power of Lighthouse Apparatus. O. Bourdelles (E-Dec. 28.) 4400 w.

*28349. The Port of Falmouth. Ill. (Tr-Dec. 28.) 1500 w.

28359. Launching of a Great Steamship.—The Most Delicate and Responsible Part of the Ship Builder's Work. Ill. (I Age-Jan.) 1100 w.

Serials.

16636. Marine Engine Design (M W-Began Oct. 6, 1893—18 parts to date—30 cts. each).

21969. The Shark and the Sailor. A. Ewbank (I E-Began April 14—23 parts to date—45 cts. each).

26091. Some Points in Modern Marine Engine Practice (I & I-Began Oct. 12—12 parts to date—30 cts. each).

27378. Water-Tube Boilers and Their Application to War Vessels. J. Nastoupil (A E R J-Began Dec.—2 parts to date—30 cts. each).

27675. Experiments on the Strength of Cylindrical Shells. Ill. J. C. Spence (E-Began Dec. 7—Ended Dec. 14—2 parts—30 cts. each).

27701. Cellulose, and Its Application to War Ships. Em. Cheneau (I & I-Began Dec. 7—2 parts to date—30 cts. each).

28356. Navigable Diving Vessels. Sydney H. Hollands (P Eng-Began Dec. 28—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MECHANICAL ENGINEERING

Selecting a Steam-Engine.

UNDER the supposition that a man has decided that a steam-engine is the kind of motor needed for his service, he is at once confronted with the question, far more formidable to a layman, of selecting from the numerous engines on the market the particular one he will purchase. Differences in price, fuel economy, size, speed, ease of management, reliability in action (which includes small outlay for repair and immunity from losses due to stoppages), and other considerations will all in turn have their influence in the selection. For each engine inspected, the would-be seller will claim the maximum number of good points and the minimum of weak ones, if he confesses to any weaknesses whatever, which he will not be likely to do except under the impression that he is dealing with an expert who will see for himself all that is not frankly admitted.

Mr. Frank Gleason, in *American Machinist* (Dec. 20), gives some excellent advice to this class of purchasers, and paints in vivid tints the sort of figure they cut when attempting to do what only a disinterested expert should be employed to do.

"The average buyer of a steam-engine is a man who knows nothing about it, but thinks he knows enough to manage his own case,—just as people do in law sometimes. The result is that he finds himself confronted with all sorts and conditions of engines; and how is he to decide? No steam-engine peddler ever acknowledged that the engine he sold had weak points, from whatever standpoint it was viewed, or that it was not best wherever it was placed. The fact is that a steam-engine, like a Kentucky mule, for example, must be chosen for what you want of it, and how it is to be handled."

That an engine shall be capable of working a long time without interruption from breakdowns, or disabilities that cannot be classed as breakdowns, such as hot journals or slides, grunting cylinders, pounding on centers, and the other ills which (some) steam-engines are heir to, is considered the prime requirement. "Human nature is said to be perverse, and to the man who finds his engine breaking down, just as the hurry is on, it will always seem as if perverseness extends to inanimate things,—to wit, steam-engines. There may have been instances of steam-engines breaking down when there is no hurry over anything about the mill or factory; but, if so, there are no authentic records of such breakdowns. Sometimes an enforced stoppage in case of a breakdown, the repairing of which may cost but a trifle, will result in a very material loss, as in inability to fill orders, flooding of mines, and in various ways; in fact, a breakdown of the prime mover seldom occurs without considerable loss outside the breakdown itself, this loss depending upon the magnitude of the works and other circumstances. In one instance, strangely enough, it resulted in the loss of the building, the only fire-pump—a condition that modern practice would not tolerate—being arranged to be quickly attached to the engine, and ample for the emergency if the engine could have been started."

Modern steam-engine designs are greatly in advance of what they were a few years ago, and perhaps this adds force to the advice that laymen should employ experts to select the motor required for a particular use; and, in some cases, an engine with the old Meyer cut-off would be preferable to one of a more refined type. Such would be the case where cost of fuel is small and the higher grade of skilled attendance expensive to procure.

How Shall We Gage Wire and Sheets?

THE vigorous and timely protest made by Mr. Oberlin Smith in *Iron Age* (Nov. 29) against the new United States standard wire gage, and the humorous, yet caustic, style in which he points out its absurdities, will meet with a response

throughout engineering circles not very flattering to the authors and promoters of the law that has loaded such a mass of inconsistencies and perplexities upon the top of those already attending the use of previously existing gages. If the inch be taken as the unit of measure, the ease and accuracy with which one or more ten-thousandths of this unit can now be measured at once suggest the simplest possible scale of sizes for wire and sheets, with a range sufficient to cover all mechanical necessities. This is substantially the gage originated by Sir Joseph Whitworth, in which, Mr. Smith says, "may be seen the first glimmer of common sense yet appearing, as recorded by history, in the industry of gage-inventing." The following requirements are laid down as "the attributes of a good gage"; and it is shown that the new standard "ignores many of them."

"1. The popularity and universality which are necessary to secure definiteness of measurement in the commercial world. 2. Suggestiveness, preferably by making its unit of measurement in harmony with some other well-known unit,—as, for instance, the English inch, or convenient fractions thereof. 3. A logically progressive scale, with the smaller numbers for the smaller sizes, rather than a retrogressive one. 4. Uniformity of names or numbers,—as, for instance, from unity upward,—rather than mixing in a number of ciphers having no meaning in themselves. 5. A uniform or uniformly increasing increment in each successive size. 6. Adaptability to the convenient measurement of any substance, rather than with a limitation to a particular metal or a particular form thereof. 7. Simple and decimal fractions, rather than complicated vulgar fractions, when translated into the inch or other well-known units. 8. Capacity for additional sizes, either smaller or larger than the original ones or interpolated between the same, as requirements at first unthought of may afterward occur."

The new wire gage is criticised both from scientific and practical standpoints. Scientifically viewed, it has no rational basis, and, practically scrutinized, it is about as unhandy a scheme as ever was devised by human ingenuity. The perusal of Mr. Smith's paper will afford most people both amusement and instruction. It occupies over twelve columns, and treats the subject almost exhaustively.

Prof. Langley's Flying Machine.

THE experiments of Prof. Langley of the Smithsonian Institution, though on a much smaller and less expensive scale than those of Mr. Maxim, in England, are interesting. They have supplied further demonstration that the principle involved in the use of æro-planes underlies the solution of the problem of mechanical flight. Under the title "Sailing Through the Air," the *Boston Journal of Commerce* (Dec. 22) gives an account of the latest success of this experimenter. This outcome has, as usual, been preceded by some failures. Nature is very inexorable in the enforcement of her laws, but exceedingly reticent of hints to mortals who may be unconsciously violating them. She has no favorites. Those who most wish to obey are punished just as severely for their failure to do so as those who wilfully transgress. Her method of teaching is through such penalties. If a mechanical constructor is heavily fined, in the form of lost time, effort, and money, for producing an inoperative device, he knows, in general, that he has been working in opposition to natural laws, but he is not further informed by the penalty. He must find out for himself how he has transgressed, and be careful not to repeat the offence. In this way, through the ages, man has learned something. The principles of flight have been particularly elusive, and many disappointments have been suffered by those who have attempted their discovery. At last, however, the right way has been indicated, and the future alone can show just how far it can be pursued with available mechanical resources.

Prof. Langley's new flying machine is twelve feet long and eight feet wide over all. "There are four wings, and the caudal pair—if they may be so termed—are little more than half the size of those attached

to the body. But for the fact that the two pairs are separated by an interval of several feet, the nerveless creature might be described as a monstrous butterfly. The fine white cloth of which the wings are in part made is stretched over a light framework of numerous closely-set veins or ribs, adding to the likeness. The aluminum body is very light, weighing only about two pounds. It is nearly four feet long and the width is almost half the length, giving it a decidedly chunky appearance. In transverse action it would approximate a circle. At each end it terminates in a blunt point, the prow more obtuse than the stern, to which is attached the long and simple support for the caudal wings and the vertical rudder, the latter being very much like the rudder of a ship. Its function is to effect lateral changes of direction, the caudal wings serving to determine the vessel's course in vertical planes.

"To maintain the large wings of the inclination necessary for suspension in mid-air, or for increase of elevation, the caudal pair must be given a reverse inclination. The greater the speed, the more nearly may the two pairs constitute part of the same plane, and for this reason, the greater the speed, the smaller part of the energy will be consumed in the maintenance of an elevated position. Thus the possibilities of speed for the perfected aero-plane would seem to be without limit, —at least, the limit would be too remote for practical consideration. The propelling power is steam. It is applied through the agency of a little copper boiler and engine within the aluminum body, giving motion to a pair of wooden screws placed at the posterior end of the body. The little engine is marvelously light and powerful for a mechanism so reduced in size. The propeller-blades are hardly thicker than paper. They are about a foot long, one piece to each, and hum like a hive of bees."

Of course, this machine is only a scientific and mechanical toy; but it flies. This is quite enough for a beginning, and doubtless an era of experiments with this class of flying machine has been ushered in. With the history of artificial flight, if anything practical in this way ever result, the names of Maxim and Langley will be permanently identified, and it will, perhaps, be difficult to estimate which of these experimenters has contributed most to the advancement of the art.

Chimneys and Drafts.

ADVANCE sheets of a new chapter which is to appear in the fourth edition of *Helios*, an excellent publication issued by the Heine Safety Boiler Company, St. Louis, Mo., have been forwarded to us. In this chapter the subject of Chimneys and Drafts is treated with reference to the supply of air needed to effect the perfect combustion of a given weight of fuel, which is, of course, the only point of scientific approach, since the function of a chimney is alone to supply the air needed for combustion.

The first thing to be determined in the consideration of the capacity of a proposed chimney is the power required to be obtained from the fuel consumed. Next, the knowledge of the character and value of the fuel to be used will permit the determination of the weight required for a given time, and the computation of the weight of air needed to obtain practically complete combustion. Next, the dimensions of a chimney that will supply to the fuel the amount of air needed may be intelligently considered, and well-established formulæ may be employed for such computation by substituting therein values derived from the preceding investigations.

"What we call draft is simply the heavier (because colder) outside air to supply the place of the lighter (because heated) gases which rise from the furnace to escape up through the chimney. We cause it artificially in a furnace, just as wind is caused by the heat of the sun in nature. The difference in weight of the column of hot gas in the chimney and that of a column of the outside air of the same height is the force which causes the draft."

But the difference in weight of the two columns depends partly on the different temperatures, and partly on the different specific gravities of the two columns at any given temperature. Their specific gravities varying with the temperatures,

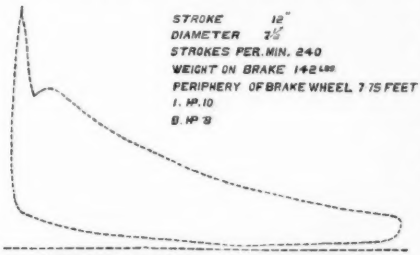
formulæ for determining these are needed, or tables by which they can be readily determined. An important feature of the treatment of the subject in the chapter under review, which has been prepared by Col. Edward D. Meier, C. E., M. E., president of the company above named, is the tabular form in which most of the needed data for computation are supplied. There are seven of these tables, each in handy form for reference, and with these and the simple formulæ any of the practical problems relating to chimneys may be quickly and easily resolved.

Not only may such problems be resolved, but a clear understanding of the principles involved may be gained from the text, so that a very complete scientific, as well as practical, essay upon chimney construction has been supplied to the book by the addition of this chapter.

An Eight Horse-Power Oil-Engine.

ANOTHER motor now rapidly pushing to the front is the oil-engine. One of eight horse-power was exhibited at the last Smithfield Club Show, held in December, and is described, among other exhibits, in *The Engineer* (Dec. 16). For small powers oil-engines have been found economical and useful, and they are gaining much favor in England. In this country they have not been appreciated so widely as their merits deserve, but doubtless some enterprising firm will ere long see and attempt to realize the commercial possibilities that lie in this direction.

"Like all others," the engine noticed



"works on what is known as the Otto-cycle. It is of the type which receives and converts the oil into gaseous vapor in a vaporizer separately heated by an oil-lamp with forced air combustion; and in which ignition is effected by an ignition tube, heated by an oil-lamp with forced air combustion."

Surprisingly good indicator diagrams were taken. A sample one is herewith reproduced. The maximum pressure indicated is two hundred and fifty-three pounds, and eight horse-power is delivered to the brake, as against ten horse-power indicated; frictional losses between piston and brake are, therefore, only twenty per cent. of the indicated power,—a very good result. Many steam motors of equal capacity would do no better, if as well.

A Cheap Planimeter.

THE planimeter and the mechanical integrator have assumed such importance among the instruments of modern engineering that probably they would be much more widely used could they be afforded at a more moderate price. Carrying out an idea suggested in *La Nature*, Mr. Fred. B. Howell has presented in *American Machinist* (Jan. 10) a cheap form of this instrument devised by him, which is illustrated in the cuts herewith reproduced.

Premising that the center of gravity of any figure can be approximately found by cutting the shape in cardboard, and thrusting a fine needle through it till a point is found where it remains indifferently in any position in a vertical plane, Mr. Howell then gives a description, in which "the method of use and construction of the instrument" are given, without going into a mathematical discussion which involves the use of the calculus. Referring to Fig. 1, which illustrates the form given in *La Nature*," it will be found, by taking a piece of wire $\frac{3}{16}$ inch in diameter and 14 inches long, and turning down 2 inches of each end, one of which is made a blunt point of tangency—of the knife edge and the plane upon which it moves—and the tracing point will be 10 inches.

"As in Fig. 2, I made the instrument by adding two attachments to Alteneder's trammel heads, substituting for the knife

head a wheel with a knife edge mounted on pivot centers, so that it could roll over the surface with as little friction as possible.

"First find as nearly as convenient the center of gravity of the figure, the area of

Fig. 1

A Cheap Planimeter

Fig. 2

A CHEAP PLANIMETER.

which is required, place the *pointer* on such point, press the *wheel* or *knife edge* into the paper to mark the starting point, and with the pointer trace in a straight line to the boundary line of the figure, around the figure, and then back to the center of gravity by the first drawn straight radiating line. Press the wheel—which has followed its own path—into the paper to mark the end of its travel, and the distance between the two depressions on the paper, multiplied by the distance from the tracing point to the point of tangency between the wheel and the plane upon which it rolls, is the area required.

"I have given the distance between wheel and pointer as 10 inches. Multiplication is performed by moving the decimal point one place to the right. . . . On figures that are more than 4 inches in any one dimension, or having more than 16 square inches, it is best that the figure be divided and the area found of the several parts."

Danger of Spring-Balance Safety-Valves.

A CASE of a boiler explosion at Dudley, England, was recently brought to the attention of the Board of Trade, which seems to have inspired in *The Practical Engineer* (Dec. 7) an editorial protest against the use of spring-balance safety-valves. The assertion is made that the use of this kind of safety-valve "has been productive of more explosions from excessive pressure than all other causes combined." While we are hardly prepared to admit the accuracy of this statement, there is no doubt that this sort of safety-valve may, and often does, become a source of danger. This kind of valve is that whereon a spring is substituted for a weight at the end of a lever, and the nature of a danger that may result in disaster is well illustrated by a brief account of the explosion referred to.

"The boiler, it appears, was employed to do miscellaneous work, amongst which was the driving of a circular saw. The attendant of this machine, being of opinion that the engine was short of steam pressure, employed the natural method which presented itself to him of remedying the defect, and screwed down the thumb-nut of the spring-balance safety-valve with which the boiler was fitted until the pointer reached the bottom of the slot. In doing this, he appears to have been under the impression that he had simply increased the load to fifty pounds, that being the figure marked on the side of the slot at this point. As a matter of fact, however, the valve was screwed down hard and fast, the pressure was bottled up, and some little time afterwards the boiler burst with disastrous effects, the whole structure being blown to fragments, which were scattered over the surrounding neighborhood to a considerable distance, while one man was killed and four others injured."

Now, this explosion was primarily due to faulty construction. A spring, so long as it is free to act, is the mechanical equivalent of a weight, except that, when stretched through a given distance, its force increases more or less, according to its length; but in the case cited the spring was not free to act at the indicated pressure at which the valve was set. A second cause was the ignorance of the attendant, who appears not to have had enough sense to see the condition of the valve, or enough knowledge to perceive that the condition

was one of danger. Such a valve should never be so made that the lever can move up against any obstruction before the valve fully opens, and the spring should be of such length as not to vary in tension very much between the full-open and full-shut positions of the valve. If "ignorant and reckless men" are to be placed in charge of boilers, it must be admitted that a spring-balance safety-valve is a thing with which the meddling of such men is very undesirable, and which to some extent increases the already existing danger of placing ignorance and recklessness in a position requiring the opposite qualities; but the valve itself, properly constructed, is not dangerous, and ought not to be so stigmatized. Any form of safety-valve, except a lock-valve, is liable to such interference; but the tampering of intelligence and prudence is not a cause for much alarm.

A 320 Horse-Power Gas-Engine.

IF anyone has supposed the gas-engine is not liable to become a powerful rival of the stationary steam-engine, a description of a 320 horse-power Simplex motor, as installed in a flour mill at Pantin, France, will probably rectify such an opinion. *The Engineer* (Nov. 30), in which the machine is illustrated and described, regards it as an illustration of "the certainty with which the steam-engine is being replaced for mill work, though slowly, by the more economical gas-engine"; and it adds that M. M. de la Marc, of Debouteville, France, as, also, Matter & Co., of Rouen, builders of the kind of engine under consideration, "believe that they now see their way to the construction of five-hundred horse-power gas-engines."

The gas for the machine is made in Buire-Lencauchez two-part gas producers, the two parts being coupled so that either can be used independently in cleaning and firing.

In a series of tests the following results were obtained. The diagrams taken from time to time gave a maximum of 280 horse-power, corresponding, it is stated, by reference to other experience, to 220 brake horse-power. The gross consumption of coal per indicated horse-power—no deduction being made for cinders or ash—was 0.788 pounds per French horse-power and 0.803 pounds per British horse-power; which represents, also, 1.028 pounds per French brake horse-power, or 1.043 pounds per British brake horse-power. In this trial 3000 liters of water were consumed per hour for washing the gas, and 6100 liters for jacket-cooling.

It is claimed that the Buire-Lencauchez gas producers have obviated the hitherto-existing necessity for using anthracite coal (almost any kind of coal being now available), and that thus the cost of producer gas has been much reduced. This advance is considered as insuring the final supremacy of the gas-engine over all other stationary motors.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

The Machine Shop.

27619. Tool Dressing—The Racker and the Side Tool. Ill. B. F. Spalding (A M–Dec. 13.) 2200 w.

27798. Pattern for a Pipe Connecting a Rectangular to a Circular Section. Ill. George Guntz (A M–Dec. 20.) 600 w.

*28030. Crank Building. Ill. G. T. G. (M W–Dec. 21.) 1400 w.

28154. Rebabbitting Boxes. C. R. Tompkins (A S–Dec. 29.) 1200 w.

Steam Engineering.

*26884. A Method of Determining the Point of Cut-off Corresponding to a Known Mean Effective Pressure. John H. Barr (S J E–Nov.) 1400 w.

26936. Some Old French Boilers. Ill. (S V–Nov. 15.) 1300 w.

†27232. The Effect of Clearance on the Economy of a Small Steam Engine. Ill. G. W. Bissell (A S M E–Dec.) 600 w.

*27549. California Crude Oil and Its Use as Fuel. A. M. Hunt (I S F–Dec.) 5000 w.

*27575. The Temperature Entropy Diagrams. H. F. W. Burstall (P Eng–Nov. 30.) 2600 w.

27595. The Steam Engine Indicator.—Errors

We supply copies of these articles. See introductory.

Due to Reducing Motion. Ill. (Pr-Dec.) 1000 w.

27718. The Engineering of Steam Plants. (E R-Dec. 15.) 2000 w.

27719. Are There Certain General Principles Underlying the Proper Connection of Steam Boilers and Engines in a Power Plant? Theodore F. Scheffler (A G L J-Dec. 17.) 3000 w.

*27764. The Danger of Spring Balance Safety Valves (P Eng-Dec. 7.) 1100 w.

27799. Drop Losses in Multiple Expansion Engines. Charles M. Jones (A M-Dec. 20.) 1500 w.

27800. Selecting a Steam Engine. Frank Gleason (A M-Dec. 20.) 1400 w.

27890. Condensers. Benjamin Thurtell (S E-Dec.) 1500 w.

27891. Theoretical Practice. R. Andresen (S E-Dec.) 2200 w.

27894. Compound Engines (B J C-Dec. 22.) 1100 w.

27896. A Fixed Cut-off and Throttling Regulation vs. Automatic Variable Cut-off for High Expansion Engines (Eng-Dec. 22.) 1800 w.

*27963. The Strength of Short Boilers. Ill. (E-Dec. 14.) 1300 w.

*28006. Test of a Worthington Pumping Engine at Hornsey Sluice. Alexander B. W. Kennedy (P Eng-Dec. 14.) 2000 w.

28022. "Triangular Connecting Rod" Engines. Ill. M. E. (A M-Dec. 27.) 3500 w.

28076. Small Throttling Calorimeters (B J C-Dec. 29.) 1700 w.

28094.—75 cts. Smoke Prevention. Henry J. Williams (T Q-July.) 4200 w.

*28108. Economic Tests of Boilers and Engines (C G-Dec. 21.) 2000 w.

*28129. The Distribution of Steam in Engines (P Eng-Dec. 21.) 3700 w.

*28210. Some Tests Relative to the Production of Steam. Ill. Edward Sauvage (A E R J-Jan.) 2200 w.

28246. Stationary Boiler Practice. By an Engineer (R G-Jan. 4.) 900 w.

28253. The Economical Steam Plant.—Its Design and Operation (B J C-Jan. 5.) 1500 w.

28254. About Steam Gauges—How They May Become Inaccurate (B J C-Jan. 5.) 1400 w.

*28300. The Production and Prevention of Smoke. (Abstract.) Vivian B. Lewes (J G L-Dec. 25.) 3000 w.

Miscellany.

*26811. On the Stiffness of Hemp Ropes and Leather Belting. M. Fauquier (M W-Nov. 9.) 600 w.

27188. How Shall We Gauge Wire and Sheets? Oberlin Smith (Ir Age-Nov. 29.) 4800 w.

*27462. The Professing Mechanical Inventor.—How to be Supplanted—Inspired Genius. Henry Harrison Suplee (E Mag-Feb.) 3000 w.

*27470. Cycle Tires. Ernest M. Bowden (Irm-Dec. 1.) 1200 w.

*27474. The Independent "Chain" Machine.—A Successful New Electrical Undercutting Coal Mining Machine. Ill. (C E-Dec.) 1500 w.

*27488. 320-Horse-Power Simplex Gas Engine and the Pantin Flour Mill. Ill. (Eng L-Nov. 30.) 1500 w.

*27522. The New Wishaw Steel Works of the Glasgow Iron Company. Ill. (E Rev-Nov. 20.) 3500 w.

*27523. The Rise and Progress of Glasgow Industry, with Descriptions of the Principal Works. Ill. (E Rev-Nov. 20.) 9500 w.

†27583. Indian Arts and Industries (I E-Nov. 3.) 1400 w.

27658. Fly-Wheel Accidents. Archibald Sharp (E W-Dec. 15.) 2200 w.

†27794. Experimental Determination of the Quickness of Action of a Shaft Governor, and Theoretical Consideration of the Influence of an Inertia Weight. D. S. Jacobus (S In-Oct.) 1200 w.

27797. The Factor of Safety in Machine Design. William Kent (A M-Dec. 20.) 1200 w.

27807. The Cambon System of Reducing the Number of Accidents in Workshops. Ill. (S V-Dec. 15.) 1000 w.

27813. Progress of Compressed Air (Sc A-Dec. 22.) 2000 w.

27818. The Manufacture of Burglar Proof Vaults. Ill. (Sc A S-Dec. 22.) 1100 w.

27819. Single Cylinder Simplex Gas Motor of 320 Horse Power. Ill. (Sc A S-Dec. 22.) 2500 w.

†27885. Connecticut Work and Workmen. George L. Porter (Tr A M E-Oct.) 3000 w.

27895. Sailing Through the Air.—Successful Trial of Langley's Latest Aeroplane (B J C-Dec. 22.) 500 w.

27898. Pneumatic Tires (Eng-Dec. 22.) 900 w.

*27958. Canet Quick-Firing Artillery. Ill. (E-Dec. 14.) 4500 w.

*27968. The Atlas Works, Glasgow. Ill. (Eng L-Dec. 14.) 8700 w.

*27969. The Smithfield Club Show. Ill. (Eng L-Dec. 14.) 1400 w.

28010. An Excavating and Conveying Cableway Plant at Niagara Falls, Ont. Ill. (E R-Dec. 22.) 1600 w.

28019. Piping for Compressed Air. Frank Richards (A M-Dec. 27.) 2500 w.

28020. Elasticity and Resistance of Materials. Gus. C. Henning (A M-Dec. 27.) 1600 w.

28024. Compressed Air Transmissions with Electrically Heated Compressed Air Engines. Thomas J. Fay (E E N Y-Dec. 26.) 700 w.

*28070. A New Motor Gas Plant. Ill. B. H. Thwaite (E Rev-Dec.) 1700 w.

*28103. The Gigantic Wheel. Ill. (Eng L-Dec. 21.) 1700 w.

*28119. Lilienthal's Experiments in Flying. Ill. (N-Dec. 20.) 1300 w.

28121. Talks to Young Engineers. William O. Webber (M A-Jan.) 1400 w.

*28133. An Astonishing Claim to Mechanical Flight: Achieved "Alone and Almost Unobserved." Editorial (Inv-Dec. 22.) 2400 w.

28172. The Curiosities of Clockwork. Ill. M. Planchon, in La Nature (Sc A-Jan. 5.) 1600 w.

28174. Ball Bearing Axles and Rubber Tires. (Sc A S-Jan. 5.) 4800 w.

28175. The Measurement of Power. Ill. G. D. Hiscox (Sc A S-Jan. 5.) 3200 w.

28177. A Proposed New Standard Screw Thread. Ill. (A M-Jan. 3.) 600 w.

28236. The Future Manufacturing Situs of the United States. Edward Atkinson (T-Jan. 1.) 2500 w.

28292. Small vs Large Machine Shops. W. D. Forbes (I T R-Jan. 3.) 2000 w.

*28312. Hints to Beginners in the Drawing Office. Ill. Ernest Scott (E E L-Dec. 28.) 4000 w.

28334. Pendulum Governors under Working Conditions. F. E. Lammert (Pr-Jan.) 2300 w.

28382. A Cheap Planimeter. Ill. Fred B. Howell (A M-Jan. 10.) 400 w.

Serials.

15534. The Gas Engine (M W-Began June 2, 1893—13 parts to date—30 cts. each).

16781. Rope Driving. Ill. J. J. Flather (E W-Began Oct. 26, 1893—13 parts to date—15 cts. each).

17900. Machine Shop Milling Practice. Ill. Horace L. Arnold (A M-Began Dec. 7, 1893—16 parts to date—15 cts. each).

18044. Motive Power and Gearing. E. Tremlett Carter (El-Began Dec. 1, 1893—29 parts to date—30 cts. each).

19638. Blowing Engines and Machinery. Ill. Albrecht von Ihering (E M-Began Feb.—10 parts to date—30 cts. each).

20182. The Elements of Boiler-Making. Ill. C. E. Fourness (L E-Began March—11 parts to date—30 cts. each).

21141. High Speed Steam Engines. Ill. John Radinger (E M-Began April—9 parts to date—30 cts. each).

24930. Some Notes for Enginemen and Firemen. W. H. Booth (E L-Began Aug. 31—11 parts to date—30 cts. each).

25528. The Designing and Construction of Modern Steam Engines. Ill. Theodore F. Sheffler, Jr. (M A-Began Oct.—4 parts to date—15 cts. each).

25538. Testing of Engines and Boilers. Charles Day (P Eng-Began Sept. 21—8 parts to date—30 cts. each).

25611. Calculation of a Compressed Air Transmission When the Subsidiary Losses of Energy are Taken Into Account. Ill. From Professor Unwin's "Development and Transmission of Power" (E M-Began Oct.—2 parts to date—30 cts. each).

26463. The Slide Rule in the Shop. William Cox (M A-Began Nov.—3 parts to date—15 cts. each).

26661. The Selection of Motive Power. Charles E. Emery (E Mag-Began Jan.—2 parts to date—30 cts. each).

26752. The Cost of Steam Raising. J. Holliday (M W-Began Nov. 2—Ended Dec. 9—4 parts—30 cts. each).

27182. Notes on the Construction and Use of Pressure Gauges. C. R. L. Lemkes (M W-Began Nov. 23—4 parts to date—30 cts. each).

27241. The Law of Invention. Horace Pettit (J F I-Began Dec.—Ended Jan.—2 parts—45 cts. each).

27318. The Buckingham Works, York. Ill. (E-Began Nov. 23—Ended Nov. 30—2 parts—30 cts. each).

27423. Repairing Steam Engines (S M-Began Dec. 1—2 parts to date—15 cts. each).

27520. Gas Power. Ill. J. Emerson Dawson (E Rev-Began Nov. 20—2 parts to date—30 cts. each).

27573. The Modern Development of the Gas Engine. Ill. James Atkinson (P Eng-Began Nov. 30—Ended Dec. 7—2 parts—30 cts. each).

27574. The Stresses on Hemp Ropes and Leather Belts Used for Driving. Ill. M. Fauquier (P Eng-Began Nov. 30—Ended Dec. 7—2 parts—30 cts. each).

27594. Erection of the Corliss Engine. Ill. A. S. Mann (Pr-Began Dec—2 parts to date—15 cts. each).

27633. Engine Governors and Governing Mechanisms. Ill. R. Gordon Blaine (M. W-Began Dec. 7—2 parts to date—30 cts. each).

27634. The Principles and Practice of Hydro-extraction. H. B. Ransom (M W-Began Dec. 7—2 parts to date—30 cts. each).

27638. Rope Tramways (I E-Began Nov. 10—1 part to date—45 cts).

27659. Fly-Wheel Accidents. W. Stuart-Smith (E W-Began Dec. 15—2 parts to date—15 cts. each).

27697. Conditions Which Determine the Choice of a Steam Engine. J. W. Hall (I C T-Began Dec. 7—2 parts to date—30 cts. each).

27746. The Reynolds' Smoke Abating Furnace. Ill. (A S-Began Dec. 15—2 parts to date—15 cts. each).

27897. Practical Steam Engineering (Eng-Began Dec. 22—2 parts to date—15 cts. each).

28021. Attachments and Conveniences for Universal Milling Machines. Warren E. Willis (A M-Began Dec. 27—1 part to date—15 cts).

28095. Results of Tests Made in the Engineering Laboratories (T Q-Began July—1 part to date—75 cts).

28115. The Utilization of Wind Power. Rankin Kennedy (E R L-Began Dec. 21—Ended Dec. 28—2 parts—30 cts. each).

28181. The Use of Compressed Air. Anon. (P A-Began Jan. 1—1 part to date—15 cts).

MINING & METALLURGY

The Technology of Explosives.

In a recent lecture before the Lancashire and Cheshire undermanagers' association Mr. W. J. Orsman gives about as thorough a review of the whole range of modern explosives as it is possible to offer within the prescribed compass. Only a few of the points (which we obtain from the report of the lecture in the *Iron and Coal Trades Review*) will be even mentioned here, but they are of interest especially in the way of a rational classification of the high explosives, the endless variety of which (at least so far as is indicated by the long string of trade names) is bewildering, unless some such grouping is borne in mind.

Notwithstanding the large number of explosives known and suggested, all of them, says Mr. Orsman, derive their explosive properties from two causes,—namely, the results of heat and pressure. "Explosion may therefore be caused by intensely rapid combustion, and as a general rule explosives owe their force to the generation of pressure, caused by rapid decomposition, or by combination of certain elements, the products formed being largely expanded by the heat evolved, and the destructive effect being regulated by the time taken in producing the change of state. All ordinary explosives consist of two parts,—the combustible elements and the oxidizing body." Thus common gunpowder—a mechanical mixture—has an average composition of about: potassium nitrate, 75; charcoal (carbon), 15; sulphur, 10 parts. For different purposes it varies somewhat. A cheap black blasting powder consists of: nitrate, 65; charcoal, 15; sulphur, 20 parts. Until quite recently the superiority of gunpowder for ordnance depended on the fact that it is possible to regulate the speed of combustion and arrange that the powder shall commence to burn comparatively slowly, so as to gradually overcome the inertia of the projectile without too great strain, while the combustion shall increase so rapidly as to give the maximum impulse (and highest velocity) as the projectile reaches the muzzle. To produce this result artillery powders—such as the cocoa powder—are much slower in burning than ordinary gunpowder, and average about: nitrate, 79; carbon, 18; sulphur, 3 parts. The chemical reactions which take place when gunpowder burns depend on the method of firing and whether it is loose or confined. It has the two combustible elements, carbon and sulphur, and the oxidizing salt, potassium nitrate, which contains as much oxygen as 3000 times its own volume of air. The oxygen combines with the carbon to form carbon dioxide and monoxide; the sulphur (added to expedite composition) combines with oxygen and potassium, forming potassium sulphate. One cubic inch of powder yields about 270 cubic inches of gas, measured when cold, which is expanded by the heat of combustion to nearly 3000 cubic inches, and, if confined, would exert a pressure of about 30 tons per square inch. The smoke consists mainly of finely divided particles of potassium sulphate, with some potassium carbonate and other compounds, and amounts to over 50 per cent. by weight of the total products of combustion. In "smokeless" powders the object is to have the products of combustion entirely gaseous.

The gun-cotton family of explosives are made by the action of strong nitric acid on cotton, paper, starch, sawdust, and other similar organic substances. Gun-cotton, etc., differ from gunpowder in that they do not consist of a mechanical mixture, but are chemical compounds containing the combustibles and the store of oxygen in the same molecule. The action depends upon mode of firing and confinement. Nitrated sawdust was an early advance in the line of smokeless powders. Then followed the method of dissolving nitrated cotton in a volatile solvent, evaporating

the solvent off, and molding the remaining horn-like material into various forms. Later, good results have been obtained by dissolving an excess of nitro-cotton in nitro-glycerine with the aid of a small proportion of camphor, giving a product that can be molded or rolled into sheets. Cordite is a new preparation of the same class, supposed to be of more stable composition, and is made in the form of wires or rods. In all these and other high explosives the great question is whether they will withstand, unchanged and unharmed, the vicissitudes of climate, transport, and storage.

Up to 1868 the firing of explosives was accomplished by simple application of heat. Then the discovery that decomposition could be brought about by intense shock, and with intensified effects, led to the introduction of detonators ("caps") containing fulminate of mercury. The explanation of the apparent paradox of such a small quantity of fulminate causing the decomposition of an unlimited quantity of high explosive, according to Berthelot, is that "the shock of the primary explosion communicates to the layer of molecules in the immediate proximity an enormously active force, whereby the 'molecular edifice' is shaken to pieces and the initial force is augmented to a degree corresponding to the heat evolved by decomposition. A new shock is thereby produced in the next layer, and the action is repeated and so propagated until the whole molecular system is completely destroyed." These effects are almost instantaneous. Gun-cotton can be detonated even if it is wet.

Glycerine was nitrated by Sobrero in 1845, but it was not until 1863 that the value of nitro-glycerine as an explosive was demonstrated by Nobel. Being a liquid and easily exploded, many accidents occurred from leakage. To obviate this danger, Nobel formed certain plastic preparations (the dynamite group) by mixing nitro-glycerine with absorbents. Giant powder, one of the most important combinations, consists of nitro-glycerine absorbed (in various proportions) by kieselguhr, a porous silicious earth composed of the remains of microscopic animalculæ. This inert absorbent is replaced in some other explosives of the class by other substances which are themselves combustible or even explosive.

Blasting gelatine (said to be the most powerful explosive, bulk for bulk, now in use) is made by dissolving nitro-cotton in nitro-glycerine, the latter losing its fluidity, the product being a jelly-like mass.

Picric acid (tri-nitro-phenol) is prepared by acting on carbolic acid (phenol) with nitric acid. It can be detonated by fulminate. Potassium picrate was introduced about twenty-five years ago, and improved upon by the substitution of ammonium picrate. Picric acid is made less sensitive to percussion by being melted and poured while in a molten state into shells, or by making the grains into a solid mass with collodion an increased weight of explosive can be got into a given space. Melinite, the French military explosive, is said to be a picrate.

The Sprengel group of explosives are mixtures of two solids, or of a solid and a liquid, or of two liquids—one of which is a hydrocarbon, containing carbon and hydrogen in a condition favorable to rapid combustion, while the second is an easily decomposable substance rich in oxygen. The two constituents are for safety kept and transported separately, and mixed, in definite proportions, just before using. Rack-a-rock, a mixture of potassium chlorate and petroleum, is the best known type and is much used in blasting. Benzine, benzol, etc., are substitutes for petroleum. Hellhoffite, a mixture of nitrated tar oils with the strongest nitric acid, and oxonite, containing picric and nitric acids, belong to this class, and are mixed when they are to be used. The use of the foregoing explosives is prohibited in England because they are believed to be specially sensitive and more or less unstable after being once mixed; and in 1886 a new group of explosives was introduced, consisting of di-nitro-benzol, or nitro-naphthaline, mixed with either ammonium nitrate or potassium nitrate. Ammonite, bellite, roburite, and securite are the principal explosives of this class, and are much used

in mining work. Roburite, which seems to be the especial favorite of Mr. Orsman, is a typical example. It is a simple mixture of ammonium nitrate with chlorinated meta-di-nitro-benzol. It is deliquescent, and consequently the finished explosive must be kept in waterproof cartridges, out of contact with the atmosphere, made so by dipping in melted wax. It is claimed that, unlike gunpowder and the nitro compounds and mixtures of other classes, it is impossible to explode roburite by percussion, fire, or electric spark, but only by a detonating wave such as is produced by fulminate of mercury. Mr. Orsman lays down the following conditions for safety explosives to be used in dusty or gaseous coal mines, and states that roburite fulfils them: (1) The temperature of detonation must be as low as possible; (2) the products of decomposition must be entirely gaseous and non-combustible; (3) the explosive must not be liable to detonate except by means of a detonator; (4) it must not be liable to ignition by spark, fire, or partial miss-shot; (5) the resultant fumes must not be poisonous; (6) the cartridge must not be liable to freeze. The author here omits to mention some other important conditions, as strength, stability, and certainty of complete detonation at the proper moment. He points out further on, however, that with safety explosives, and in fact with all explosives, the danger lies in the possibility of incomplete combustion, which can only be overcome by having an excess of available oxygen; but this unfortunately means greatly increased temperature. To tone down the temperature of nitro-glycerine compounds, wood meal, as in carbonite, has been introduced, but is said to produce carbon monoxide, a poisonous gas, although a fair degree of safety is attained. The latest explosive of the Sprengel type is westphallite, an intimate mixture of ammonium nitrate with resin or shellac, which requires a very strong detonator.

Mr. Orsman's conclusion as to safety explosives is: "No explosive in which complete detonation takes place ever has been, or, I venture to think, ever will be, produced that will not generate sufficient heat to ignite an explosive mixture of gas." This discouraging dictum will of course be vigorously assailed by the advocates of the many newly introduced or proposed safety explosives, but should give comfort to the friend of the water cartridge, the lime cartridge, etc.

Hydraulic Mining in California.

UNDER the caption, "A History of the Miners' Movement," the *Mining and Scientific Press*, of San Francisco, reviews the course of the long and bitter struggle between the farmers and placer-miners of California, its effects, the attempts at compromise for the purpose of resuming hydraulic mining under restrictions, legislation regarding the matter, and the present condition of the industry. The subject is one of more than local importance, since the enforced suspension of this branch of mining meant that a supply of about $10,000,000 in gold annually had been shut off, and that, unless some mode of rehabilitating it were found, the enormous reserves of auriferous gravel would be left unavailable. Most of the readers of this Magazine are doubtless more or less familiar with the subject, but an abstract of the article in the *Press* may serve to put it in a clearer light.

While the gravel mines of California worked by the hydraulic method had been yielding many millions of dollars yearly, they had at the same time been pouring forth a flood of *débris* (tailings) into the river channels, obstructing the navigable streams and adjacent farming lands. The farmers whose property was damaged started what is known as the "anti-*débris*" agitation, and a long-continued litigation in the courts ensued; finally, in a test case, a decision in favor of the farmers enabled them to obtain injunctions closing mine after mine, until at last practically all the mines discharging tailings into the interior drainage basin were forced to cease operations. For many years hydraulic mining in California was dead, so far as the principal district was concerned. The miners were in the minority. At first the decisions of the courts met with general ap-

proval outside the mining regions. The distress was great, but appeared to be confined to the mining communities, in which, of course, everything was at a standstill, with men out of work, all the interests dependent upon hydraulic mining stagnant, and some of the towns almost depopulated. But the trouble spread. The decisions against miners amounted to a practical confiscation of their property. It was shown during the trials that upwards of $100,000,000 had been invested in the hydraulic mines, ditches, etc., and virtually wiped out. The mines could not be worked under the rulings, nor could they be sold. This condition of affairs affected not only the miners and the local tradespeople, mechanics, and others associated with them, but the outside investors and the State at large.

After ten or twelve years of stagnation, the first signs of a revival were shown by the action of the governor and legislature in seeking for a remedy, which, under the conditions, seemed out of their own reach. The legislature memorialized congress to appoint a commission to examine the rivers and hydraulic mines and take such measures as would enable the mines to be reopened. In the meantime another commission previously appointed reported in favor of building retaining dams for the *débris*. The miners, becoming encouraged by the hope of resuming operations, held a convention in January, 1892, to which representatives from the farmers were invited. The latter had suffered as well as the miners, and a reconciliation was effected, the miners expressing themselves as willing to impound their *débris* in the future, and the farmers withdrawing their opposition on that understanding. A State miners' association was organized, which has been very active and has been supported by all classes. After a struggle, the Caminetti bill was passed by congress. It was an unsatisfactory measure, but formed the basis of an arrangement by which hydraulic mining might be resumed under restrictions.

Under the federal and State concurrent laws the miners, in order to work claims by the hydraulic method, must provide impounding works in which to retain the tailings. The whole matter of operating is placed in the hands of the State *débris* commission, which alone has the right to issue licenses to mine in the central drainage basin. Under these conditions the output of the mines is limited by the capacity of the settling reservoirs, and they cannot be as productive or profitable as formerly, when without restrictions. At present about fifty hydraulic mines are working in the district affected by the *débris* question, while many applications for licenses are pending. Before the present law was passed, all of these mines could have been enjoined. There are still two bills pending in congress relating to the matter, and there is much controversy over them.

Iron or Steel Head Frames.

THE *Colliery Engineer* has an illustrated article on the history of iron and steel head frames at Pennsylvania coal mines and their advantages over timber frames, which will command the attention of mine managers elsewhere. The first iron head frame for a shaft in Pennsylvania, and probably the first in America, was built by the Philadelphia & Reading C. & I. Co., at the Pottsville shaft, but, as it was located at an unprofitable opening, it did not receive much attention, and therefore had little effect in advancing the use of such head frames at other mines. The first steel head frames for productive Pennsylvania collieries were erected at the Oliver mine and at the Connellsville mines of the H. C. Frick Coke Co. These being found successful, others were speedily built, until now steel head frames are common in western Pennsylvania. The first steel head frame in the anthracite region was put up at the Nottingham colliery, Plymouth, where 633,000 tons of coal are hoisted through one shaft to the top of one breaker, the wear and tear on the tower being very heavy. At Richmond No. 4 shaft, near Carbondale, is a steel head frame one hundred and eighty-seven feet high, with a base fifty-two feet square, the great height being necessary to give grade for a shoot to the top of the breaker,

which, in accordance with the State anthracite mine law, has to be at least two hundred feet from the shaft. Self-dumping cages are used. This was a radical departure from the usual method of handling coal, but it meets with general approval. It is estimated that the saving by the use of steel in this case is at least sixteen hundred dollars a year, not allowing for the fact that wooden head frames must be renewed every six or eight years, while it is thought that, when the colliery is exhausted, the steel in the tower and shoot will have a market value of about two-thirds its original cost.

Mica in Alabama.

IN *The Tradesman* Mr. Wm. Brewer gives an account of the present condition of mica mining in Alabama, in which State, he says, investigation proves that there are three distinct belts of coarse-grained granite containing mica of commercial value. These belts have the general northeast-southwest trend of the other mineral belts in the crystalline rocks of the region. The most extensive work has been done on the northernmost, in Randolph county, but the distance from railroads and the high cost of wagon-haulage are great drawbacks. The workings are shallow. "In order," says Mr. Brewer, "that mica mining may be profitable, deep mining is necessary. In a word, water level must be reached before profitable results can possibly follow, for these reasons: (1) The mica crystals near the surface are nearly all more or less stained with iron oxid. (2) The mica sheets near the surface are nearly always very much cracked, broken, and rotten; consequently less than two per cent. of the product is merchantable. (3) Below water level, wherever such depth has been attained, the quality and size of the crystals are much superior, and the quantity of marketable mica is a much larger percentage." Speaking of the industry at large, the author states that, although mica mining is really one of the older mining industries of the country, it is only recently that the demand for mica has been otherwise than limited. To-day the demand is really in excess of the supply so far as home mining is concerned and most of the mica used in the United States is imported from Canada and India. This increased demand is due to the extensive use of mica in electrical appliances. The demand for ground mica, for which the waste from dressing the sheets can nearly all be used, is also increasing, this product being used as an ingredient in lubricants for heavy bearings and in certain insulating compounds. Scrap mica is now being made into large artificial sheets, under the trade name of "micanite."

On the whole, "mica mining," says Mr. Brewer, "is, to tell the exact truth, one of the most hazardous kinds of mining, because, while the mineral occurs in veins, yet these always have a lenticular shape, connected by stringers the product of which is rarely sufficient to pay expenses; and indeed sometimes the pockets are entirely unconnected, except by the continuity of the quartz and feldspar constituents of the granite, with small crystals and flakes of mica. Consequently mining is costly, as well as for the additional reason that at best from four to six per cent. only of the total product is marketable. In fact, the percentage is often less, especially near the surface." A good deal of misunderstanding prevails with regard to the price of mica. Lists quoting it from five cents to thirteen dollars a pound are misleading. "As a matter of fact, the largest consumers limit their price between five cents and one dollar a pound, according to size, and have no trouble in purchasing all they desire at these prices." But the author considers that the constant increase in the demand, while the supply is limited, should encourage the owners of mica properties to work them, and to endeavor to lessen the cost of mining and dressing in order to enable them to compete with foreign producers.

The Dahlonega Gold-Mining District.

THIS historic gold field is still the scene of active mining operations,—conducted not on a very large scale, but successfully and economically, and worthy of note because of the peculiar methods pursued. Lumpkin

county, Georgia, in which it is situated, has the reputation of having produced more gold in the past sixty-nine years than any other portion of the southern United States. Prof. Wm. M. Brewer contributes to the *Engineering and Mining Journal* an interesting account of the present condition of the field, from which it appears that seven mines, with mills of from ten to forty stamps each, are now actively worked, besides one dredge-boat on the Chestatee river, and a number of men working in a small way sluicing on leased ground. Altogether about three hundred men are engaged in gold mining in the district. There are nearly eighty miles of ditches and flumes, the main canal carrying six hundred miner's inches. The mills are all run by water power. The usual system of mining is a combination of hydraulic mining and transport, and milling the quartz. No deep mining has been done on any location. The mines so far developed are on parallel leads in a semi-crystalline state, overlaid by schists and gneiss, the latter graduating into granite. Much of the ore occurs in hornblende and gneissoid schists, in narrow seams of quartz, much decomposed at the surface, which explains the reason for adopting the combination system of mining. The material is blasted or picked and broken in open cuts on the mountain side and transported through sluices to the ore bins at the mills, where it is fed by hand into the mortars, and amalgamated. A portion of the length of the sluices is lined with riffles, which catch the coarse gold. The cost of mining and milling is stated at only twenty-five cents a ton, and the average yield at two dollars. This extremely low cost (which compares favorably with the famous record of the Spanish mine, California) is accounted for by the fact that miners' and millmen's wages are only eighty cents to one dollar a day, and that water is the only power used for transportation and running the machinery. Up to the present time no attempt has been made to concentrate and save the sulphurets, although some of the ore contains much. Experiments are now being made in this direction. A dredging company is excavating a canal to drain the bed of the Chestatee river, which, with two hundred and fifty acres of placer ground, will be the center of its operations. In this plant electricity derived from water power is used for pumping.

The Boom in Gold Mining.

THE London *Mining Journal* calls attention to the boom which has lately set in in the gold mining industry, or rather to the revival of the speculative interest, and says that the temper of the speculating public is hard to forecast. After deserting the mining share market for a long time, during which there were ample opportunities for making money in this class of investments, it has suddenly started a boom in them, and this in advance of a revival in other interests. The *Journal* had predicted that a renewal of speculation would take this particular direction, because the experience of the English public had been less disastrous in mining than in other foreign industries. But the *Mining Journal* considers it surprising that the excitement should have confined itself so strongly to new mining enterprises, ignoring the old. Thus the boom in the new Western Australian mines has been quite unattended with a similar movement in the shares of the smaller of the South African mines, and our contemporary states that there has been a considerable withdrawal of English support from these mines, while recent purchases have been mostly on account of German and French capitalists. This the *Journal* ascribes to the strong interest which the charm of novelty exerts even in the prosaic regions of finance. While the *Journal* has recognized the importance of the new discoveries, it now sounds a note of warning against overdoing the matter, and intimates that the promoters have taken advantage of the prevailing popular feeling to float many doubtful projects. A comparison is drawn between the now well ascertained continuity and regularity of the Transvaal deposits and the unknown conditions of some of the Western Australian properties lately put upon the market, and the inference is not flattering to the latter. This, however,

is something often paralleled. The *Journal* does not in the article quoted refer to the recent and continuing interest in American gold mines, and more especially to those in newly found districts; and it might be added that the depression in silver mining has had much to do with the transfer of attention to gold mining.

In a later issue of the same periodical, under the heading "The Future of Gold Mining," a continued upward movement in the shares of gold-mining companies is chronicled. This is considered by the *Mining Journal* to be due not so much to speculation as to the perception of the fact that these stocks had been greatly undervalued; and the large purchases on European account of shares in the dividend-paying properties of the Rand (Transvaal) appear to have been made for permanent investment. As to the Rand mines, within a short time several hundred additional stamps will be crushing ore; the recent improvements in cyanide extraction are claimed to mean a saving of forty per cent. in this part of the working expenses, while the introduction of electrical power transmission from central plants will result in another large saving in cost of motive power. The outlook in this district is believed to be extremely favorable.

Industries and Iron states that the electrolytic separation of manganese from its compounds is now performed at an establishment in Hanover, the metal so obtained being absolutely pure. It is in the form of a fine powder. To prevent loss in the crucibles consequent upon this condition alkaline chlorides are used in fusing.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Metallurgy.

27395. Malleable Castings from Coke Pig Iron. Ill. (Ir Age–Dec. 6.) 600 w.

27602. The Electro-Metallurgy of Gold and Silver. A. L. Eltonhead (E R N Y–Dec. 12.) 2500 w.

27615. Surface Defects in Ingots. J. S. Robeson (Ir Age–Dec. 13) 2800 w.

27620. Economy in Melting. Herbert M. Kamp (A M–Dec. 13.) 1600 w.

27713. Stone Coal in the Lead Blast Furnace. L. S. Austin (E M J–Dec. 18.) 1000 w.

*27737. Soldering of Aluminum and the Production of the Metal in Great Britain (Inv–Dec. 8.) 1100 w.

*27743. The Determination of Tin and Antimony in Commercial Samples. J. H. Digger (C T J–Dec. 8.) 800 w.

†27793. The Determination of Carbon in Iron and Steel. Theodore B. Stillman (S In–Oct.) 3500 w.

27795. Relative Tests of Cast Iron. W. J. Keep, with Discussion (Ir Age–Dec. 20.) 6400 w.

27863. The Use of Alloys in the Manufacture of Brass and Bronze Castings. F. J. Davis (F D–Dec.) 1100 w.

†27876. Does the Vibration of Stamp-Stains Change Their Molecular Structure? Continued Discussion of Mr. Rickards' paper on "The Limitations of the Gold Stamp-Mill." (Tr A M E–Oct.) 9000 w.

†27877. Early Days of the Iron Manufacture. John Fritz (Tr A M E–Oct.) 7000 w.

†27879. A Uniform Method for the Assay of Copper Materials for Gold and Silver. Discussion of paper by Albert Ledoux (Tr A M E–Oct.) 2200 w.

†27880. Magnesia and Sulphur in Blast-Furnace Cinder. Frank Firmstone. Discussion. (Tr A M E–Oct.) 1300 w.

†27881. Losses of Gold and Silver in the Fire-Assay. H. Van F. Furman (Tr A M E–Oct.) 2000 w.

†27882. Pyrometry and the Heat-Treatment of Steel. Henry M. Howe (Tr A M E–Oct.) 1000 w.

†27883. The Inaccuracy of the Commercial Assay for Silver. Discussion of the paper of C. A. Stetefeldt (Tr A M E–Oct.) 1200 w.

†27884. Further Experiments on Amorphous Gold. Henry Louis (Tr A M E–Oct.) 1800 w.

*27918. The Fuel Element in Blast Furnaces. E. de Billy (C G–Dec. 14.) 4000 w.

*27920. The Removal of Clay from Iron Ores. Walter J. May (C G–Dec. 14.) 1000 w.

*27971. Face Hardened Armor in the United States. Editorial (Eng L–Dec. 14.) 1400 w.

27980. Machine Molding. Harris Tabor, with Discussion (Ir Age–Dec. 27.) 5200 w.

†28086. The Future of Gold. Robert E. Preston (N A R–Jan.) 3000 w.

*28105. Presidential Address of J. E. Stead (C G–Dec. 21.) 2500 w.

28157. The Chicago Iron Trade in 1894 (Ir Age–Jan. 3.) 3500 w.

We supply copies of these articles. See introductory.

28158. The Pittsburg Iron Trade in 1894 (Ir Age–Jan. 3.) 3600 w.

†28192 Melting and Refining Gold Bullion. H. Van F. Furman (S M Q–Nov.) 2500 w.

†28235. The Resistance to Corrosion of Some Light Aluminum Alloys. Joseph W. Richards (J F I–Jan.) 900 w.

28242. The Manufacture of Iron in the South. William M. Bowron (T–Jan. 1.) 5500 w.

28243. Southern Rolling Mills. W. H. Hassinger (T–Jan. 1.) 2200 w.

28245. Will the South Manufacture Steel? A Symposium by Prominent Iron Masters of the Country (T–Jan. 1.) 4500 w.

28288. Fine Ores in the Blast Furnace. F. B. Richards (I T R–Jan 3.) 1700 w.

28293. Improvement in Foundry Methods—Views of Practical Men on Recent Developments (I T R–Jan. 3.) 1800 w.

28294. New York Metal Market, 1894 (E M J–Jan. 5.) 5000 w.

28295. Review of Boston Copper Stocks in 1894 (E M J–Jan. 5.) 1200 w.

28300. The Evolution of the Art Idea in American Hardware. A. W. D. (A S–Jan 5.) 1000 w.

*28350. Recent Progress in the Manufacture of Steel. (Abstract.) James Riley (I C T–Dec. 28.) 3400 w.

*28351. On the Condition of Carbon in Steel. (Abstract.) F. A. Matthewman (I C T–Dec. 28.) 1300 w.

MINING.

26523. Gold Mining in Ecuador. A. F. Saabye (E M J–Nov. 3.) 1300 w.

*26941. The Boom in Gold Mining. Editorial (M J–Nov. 10.) 700 w.

*26958. The Technology of Explosives. W. J. Orsman (I C T–Nov. 9.) 3500 w.

*27472. Electricity in Coal Mining.—A Successful Haulage and Pumping Plant. Ill. (C E–Dec.) 1800 w.

*27473. Iron or Steel Head Frames.—Their Superiority Over Timber Head Frames for Shafts. Ill. (C E–Dec.) 1300 w.

*27489. Flameless Explosives. Editorial (Eng L–Nov. 30.) 2100 w.

*27491. Report on Flameless Explosives. A. C. Kayll, with Discussion (C G–Nov. 30.) 6500 w.

*27492. Determination of Firedamp by the Limits of Inflammability. M. Lebreton (C G–Nov. 30.) 3000 w.

*27493. Australian Coal (C G–Nov. 30.) 2500 w.

*27494. Motive Power Economically Obtained from Coal (C G–Nov. 30.) 1500 w.

*27495. The Munzer Brake-Parachute for Mine Cages. Ill. (C G–Nov. 30.) 3800 w.

*27496. Coal Mining in New Zealand. A. J. Cadman (C G–Nov. 30.) 1300 w.

*27497. The Generation of Electricity at Collieries. Walter J. May (C G–Nov. 30.) 1000 w.

*27498. The Baker Naphtha Industry (C G–Nov. 30.) 1100 w.

27535. Cochiti, New Mexico (M I T–Dec. 8.) 1200 w.

†27584. Faulting—Its Causes and Results. Ill. (I E–Nov. 3.) 1500 w.

*27589. The Safety of High Explosives (I C T–Nov. 30.) 2200 w.

27612. Vanderbilt Mining District. Fred E. Lewis (M S P–Dec. 8.) 2000 w.

†27639. The Coolgardie Goldfield. R. W. W. (I E–Nov. 10.) 1200 w.

*27681. The Belgian United Frameries Collieries (C G–Dec. 7.) 2500 w.

*27682. The Law Respecting Ways and Wayleaves (C G–Dec. 7.) 3000 w.

*27683. Explosions of Firedamp and Rapid Barometrical Depressions (C G–Dec. 7.) 1000 w.

*27684. Petroleum and Natural Gas. (Abstract.) Henry M. Cadell (C G–Dec. 7.) 5000 w.

*27685. The Coalfields of New Zealand (C G–Dec. 7.) 4000 w.

27709. Mica in Alabama. William Brewer (T–Dec. 15.) 1200 w.

27714. The Dahlonega Gold Mining District. Ill. William M. Brewer (E M J–Dec. 15.) 1200 w.

*27749. The Future of Gold Mining (M J–Dec. 8.) 700 w.

*27753. The Slate Quarries of Angers, France. Ill. (S–Dec.) 2000 w.

*27754. Granites of England. From a Monograph by Hyjalmar Lundbohm (S–Dec.) 1600 w.

*27777. The Coolgardie Goldfields (W. A.)—An Adverse View (A M S–Nov. 10.) 1100 w.

*27779. Electricity in Mines. W. E. Lishman (A M S–Nov. 17.) 2700 w.

27820. Gold Mining in Georgia (M R–Dec. 21.) 1200 w.

27831. Canals for Hydraulic Mining (Min R–Dec. 6.) 1000 w.

27858. The Rainy Lake Gold District (E M J–Dec. 22.) 1107 w.

27859. The Mineral and Metal Production of Sweden in 1893 (E M J–Dec. 22.) 1000 w.

†27878. The Nickel Mine of Lancaster Gap, Pennsylvania, and the Pyrrhotite Deposits at Anthony's Nose, on the Hudson. Ill. J. F. Kemp (Tr A M E–Oct.) 4200 w.

†27886. The Phosphates of Tennessee. Thomas C. Meadows and Lytle Brown (Tr A M E–Oct.) 4000 w.

†27887. The Mines of the Chalanches, France. T. A. Rickard (Tr A M E–Oct.) 5000 w.

†27888. Lead and Zinc Deposits of Missouri. Ill. Arthur Winslow (Tr A M E–Oct.) 19500 w.

†27889. The New Mining Law of New York. R. W. Raymond (Tr A M E-Oct.) 10500 w.

*27917. Exploration and Working of Coal and Iron in France (C G-Dec. 14.) 1100 w.

*27919. Colliery Surface Works (C G-Dec. 14.) 1000 w.

*27921. On the Influence of the Diameter of Holes in Blasting Operations. James Ashworth (C G-Dec. 14.) 1600 w.

27938. Coal in Peru (A M & I W-Dec. 21.) 1500 w.

28059. Mica; Its Uses, Mining and Trade in India. Edgar Thurston (C M R-Dec.) 4500 w.

28066. The Leadville District, Colorado, in 1894 (E M J-Dec. 29.) 400 w.

28067. Gold in Zacatecas, Mexico. Edward Halse (E M J-Dec. 29.) 1500 w.

28068. The Mining Exposition at Santiago, Chile (E M J-Dec. 29.) 800 w.

*28106. The Trien-Kaisin Colliery, Belgium, at the Antwerp Exhibition. Ill. (C G-Dec. 21.) 1700 w.

*28107. Historical Notes on Early Plans for Coal Washing. F. J. Rowan (C G-Dec. 21.) 1000 w.

*28109. Substitution of Masonry for Timber Lining Without Interruption to Winding or Pumping. Ill. (Extract.) Julien Linet (C G-Dec. 21.) 2200 w.

*28110. Blasting Explosives (C G-Dec. 21.) 1900 w.

†28191. Spring-Pole Drilling. Ill. Edgar T. Tuttle (S M Q-Nov.) 6400 w.

†28193. Electricity for Mining Plants. Eduard D. Self (S M Q-Nov.) 1700 w.

28207. S. B. Christy's Address before the California Miners' Association (M S P-Dec. 29.) 3500 w.

28240. The Mineral Resources of the South. W. M. Brewer (T-Jan. 1.) 9000 w.

28286. Coal Fields in New South Wales (A M & I W-Jan. 4.) 800 w.

28290. Mesabi Mining Costs. Ill. H. V. Winchell (I T R-Jan. 3.) 3200 w.

28291. Ores of the Mesabi Range. Richard A. Parker (I T R-Jan. 3.) 3300 w.

*28328. The Urikany and Zsil Collieries, Hungary (C G-Dec. 28.) 1800 w.

*28330. Rodde's Safety Lamp. Ill. (C G-Dec. 28.) 2300 w.

*28347. Explosions in Mines. (Abstract.) Vivian B. Lewes (N-Dec. 27.) 1800 w.

Serials.

20413. Mining Methods. Ill. (C E-Began March—10 parts to date—30 cts. each).

20414. Geology of Coal. Ill. (C E-Began March—10 parts to date—30 cts. each).

20415. Mining Machinery. Ill. (C E-Began March—10 parts to date—30 cts. each).

20416. Chemistry of Mining. Ill. (C E-Began March—10 parts to date—30 cts. each).

21814. Plate Moulding. Ill. J. Horner (P Eng-Began April 27—11 parts to date—30 cts. each).

22586. The Mineral Hydrocarbons (M S P-Began June 2—17 parts to date—15 cts. each).

22710. Science for Iron-Mongers (Irm-Began June 2—13 parts to date—30 cts. each).

25689. A Typical Gold Mine Region—Cripple Creek, Col. Ill. Arthur Lakes (C E-Began Oct.—3 parts to date—30 cts. each).

26031. European Phosphates. C. C. Hoyar-Millar (M R-Began Oct. 19—7 parts to date—15 cts. each).

26139. Aluminum. A. Humboldt Sexton (P Eng-Began Oct. 12—3 parts to date—30 cts. each).

26386. Proper Foundry Construction and the Apparatus to be Used. Simpson Ballard (T-Began Nov. 1—4 parts to date—15 cts. each).

26816. Notes on the Gold-Bearing Black Sands of California. J. A. Edman (M S P-Began Nov. 10—Ended Dec. 15—3 parts—15 cts. each).

26826. Open Hearth Steel. Ill. (Ir Age-Began Nov. 15—5 parts to date—15 cts. each).

27111. The Profits of Gold Mining. Nicol Brown (M J-Began Nov. 17—Ended Dec. 1—3 parts—30 cts. each).

27319. The Mineral Resources of the United States (E-Began Nov. 23—Ended Nov. 30—2 parts—30 cts. each).

27329. Coal Mining Economy up to Date (I C T-Began Nov. 23—3 parts to date—30 cts. each).

27356. Further Experiments on Amorphous Gold. Henry Louis (M J-Began Nov. 24—Ended Dec. 1—2 parts—30 cts. each).

27357. The Practical Operation of the Cyanide Process in the Randt. M. Eissler (M J-Began Nov. 24—Ended Dec. 1—3 parts—30 cts. each).

27358. Motive Power for Mining Machinery (M J-Began Nov. 24—5 parts to date—30 cts. each).

27450. Cupola Tuyeres. Ill. Edward Kirk (Met W-Began Dec. 8—2 parts to date—15 cts. each).

27700. Aluminum. G. B. E. (I & I-Began Dec. 7—2 parts to date—30 cts. each).

27715. The New Mining Law of New York. R. W. Raymond (E M J-Began Dec. 15—2 parts to date—15 cts. each).

27937. Coal Development on the Chesapeake and Ohio Railroad. J. D. Imboden (A M & I W-Began Dec. 21—2 parts to date—15 cts. each).

27975. The Present Status of Face Hardened Armor. (Abstract.) W. T. Sampson (I & I-Began Dec. 14.—2 parts to date 30 cts. each).

28038. The Extraction of Copper from Alloys by Means of Electrolysis. From Dr. Carl Schnabel's Handbook (A M S-Began Nov. 24—1 part to date—30 cts).

28130. Mining Reports and Mine Salting. Walter McDermott (M J-Began Dec. 22—1 part to date—30 cts).

We supply copies of these articles. See introductory.

MUNICIPAL ENGINEERING

The Physical Qualities of Building- and Paving-Bricks.

A VERY extensive table of results of "Tests of Paving-Bricks" prepared by Mr. E. S. Fickes, of Steubenville, Ohio, who also made the tests, is printed in *Engineering News* (Dec. 18). The amount of work represented in this table is large. Samples of bricks from no less than thirty-four widely separated localities in the United States are tabulated,—often a considerable number of samples from the same locality; so that one hundred and one different samples are represented. For example, six samples from Canton, Ohio, seven from Cleveland, eleven from St. Louis, ten from Philadelphia, and four from New Cumberland, W. Va., are represented.

Commenting editorially upon this table, *Engineering News* points out that its value is enhanced from the fact that the tests were all made by the same experimenter, and by the same methods and apparatus. These methods being reliable and accurate, the tabulated results ought to be very nearly correct. The table represents paving-bricks from twelve different cities, the other samples being building-bricks. An exhaustive analysis of the tabulated results enables the following rules for paving-bricks to be deduced.

"1. Paving-bricks are best tested by their resistance to abrasion when tumbled, and they vary considerably in that respect, some losing nearly three times as much weight as others for a given amount of tumbling.

"2. Any brick which will stand tumbling well has ample crushing strength, rarely chipping under less than five thousand pounds per square inch, or crushing under less than ten thousand pounds. The crushing strength tends to vary with the resistance to abrasion, however, but more slowly and irregularly.

"3. The transverse strength also tends to vary with the resistance to abrasion, but more slowly and irregularly. Good paving-brick should show a modulus of two thousand to two thousand five hundred under transverse load, but brick with small resistance to abrasion will often show high transverse strength, so that the test has only negative value.

"4. The quantity of water absorbed in twenty-four hours should be small, as an end in itself, but it is a very rude test of the quality of the bricks in other respects. The toughest bricks tend to show the least absorption, and any paving-brick absorbing much more than one per cent. of moisture in twenty-four hours is justly open to suspicion; but some of the best bricks will absorb more than thirteen per cent. of water, and some of the poorest bricks will absorb much less. All good paving bricks absorb less than two per cent., which is greatly less than the best building-bricks absorb."

For building-bricks a different set of rules is deduced, although this has been a more difficult task than it was to draw conclusions applicable to paving-bricks, requiring a rearrangement of the tests in the order of ultimate crushing strength per square inch, and subdivision into groups as follows: crushing strength—(A) 8,000 per square inch, and over; (B) 6,000 to 8,000; (C) 5,000 to 6,000; (D) under 5,000.

"1. The strength of building-brick, both transverse and crushing, varies in tolerably close inverse ratio with the quantity of water absorbed in twenty-four hours. The strongest bricks absorb least water.

"2. Good building-bricks absorb from six to twelve per cent. of water in twenty-four hours, and, with no greater absorption than twelve per cent., will ordinarily show from seven thousand to ten thousand or more pounds, per square inch, of ultimate crushing strength, and a transverse modulus of seven hundred to twelve hundred pounds or more.

"3. Poor building-bricks will absorb from one-seventh to one-fourth of their weight of water in twenty-four hours, and

average a little more than half the transverse and crushing strength of good bricks.

"4. An immersed brick is nearly saturated in the first hour of immersion; in the remaining twenty-four hours the absorption is only one-half to four-fifths of one per cent. of its weight, as a rule.

"5. The strength of bricks in the kiln is least in the top course, and increases quite rapidly for the first ten or twelve courses, and afterwards more slowly down to the arch bricks.

"6. The size of bricks varies greatly in different parts of the country, the weight varying from 3.84 to 6.34 pounds. The Eastern bricks tend to smaller sizes than do the Western, but the variation is often considerable in different makes of bricks in the same locality.

"7. Bricks made by the dry press are, as a rule, notably less porous and stronger than those made by the wet mud process. To this rule, however, there are some exceptions."

Drinking-Water in its Relation to Malarial Diseases.

MANY years ago one of two contiguous families residing in an eastern town in the United States was seriously affected with malarial diseases, while the other remained in excellent health. Their habits of living were the same; both were constantly subjected to the same climatic conditions; the only particular in which they differed was that the family which remained well took its water for domestic uses from a rain-water cistern, while the other obtained its water from a town well. Suspicion that the malarial diseases originated in the use of the well-water was thus aroused in the mind of Richard Lewis, M. D., now secretary of the North Carolina Board of Health, and, his subsequent investigations having converted suspicion into conviction, he has published his investigations and conclusions in *The Sanitarian* for December.

It has been thoroughly established that drinking-water may be the vehicle for conveying contagious diseases,—typhoid fever, cholera, etc.,—but malarial diseases have been usually ascribed to atmospheric conditions, as the word "malaria" itself indicates. While Dr. Lewis still admits this to be a common cause, he also maintains that water may be contaminated with the same poison, and cites many well-authenticated facts to sustain the view. The subject therefore has an important relation to city water-supply, and sounds a note of danger from a quarter hitherto unsuspected. The bulk of the paper is made up of accounts of cases of malarial diseases supposed to have originated in this way.

"As to the nature of the poison, many theories have been promulgated. Up to 1866 the universally accepted opinion was that it was gaseous in character. In that year Dr. Salisbury, of Cincinnati, O., announced the discovery of an alga, or small water-plant, which he assigned as the cause of malarial fever. While his conclusions were not generally accepted, inquiry on that line was stimulated, and from time to time various microscopic organisms were suggested as the cause, none of which, however, stood the test of experiment. But 'in 1881 Laveran claimed to have discovered in the blood of malarious subjects, in connection with the red corpuscles, rapidly moving filamented spherical organisms of about the same diameter as the corpuscles. . . . Many investigators who have followed in Laveran's track have corroborated his testimony, and hence there is a growing consensus of opinion that malaria is due to the introduction of *plasmodum malaria* into the system; that it attacks the red blood corpuscles, lives and grows within them, and finally disintegrates them,'—the explanation, by the way, of the familiar fact that the subjects of chronic malaria are always very pale and bloodless. Since the above was written (in 1892), favorable evidence has accumulated, and it is now generally believed that this little blood parasite—this microscopic vampire, so to speak—is the cause of this kind of disease."

That this poison is carried by water is so firmly believed by Dr. Lewis that he warns the public against the use of water from surface wells, and counsels the use of deep-

bored wells, or, when this is not practicable, the employment of cisterns, which are as good from a sanitary point of view, but not so reliable for uniform water supply.

But how about the water supplies of large cities, almost always collected from the surface into reservoirs for storage? If Dr. Lewis is correct in his views,—and they seem to have been sustained by the opinions of a great many North Carolina physicians expressed in reply to a circular requesting information,—it would seem that cities should be more liable to this class of diseases than rural districts. But this is not the case. Perhaps there may be some counteracting influence that, if known, would account for this; but, in the absence of such knowledge, the comparative immunity of cities is a fact that seems to tell against the theory of transmission of malarial diseases by surface-water.

Capitalized Cost of Street-Grades.

A PAPER on "Street-Grades and Crossings," by Mr. William B. Fuller, in *Journal of the Association of Engineering Societies* (Nov.), presents the subject in a light that will be new, at least to most laymen. In the proper determination of a street-grade there are more things to consider than is generally supposed by those not entirely familiar with this kind of work; and it may be reasonably inferred that in laying out streets, as municipal work is ordinarily conducted, some of these points are often overlooked entirely.

"There is, first, the necessity of balancing, as nearly as may be, the cuts and fills, so that the first cost may be low; next, the consideration of surface-drainage, in order that the water may not be directed in excess to any one spot, or made to discharge in a dry run which may be obliterated by private improvements, and thus force the regrading of the street or the building of an expensive drain; next, the grades should be so arranged as to do away with deep cuts for the sewers which may become necessary under the street surface, and care should be taken that the street surface is far enough above the general drainage level to provide proper cellars. All of this, as well as the need of following the natural surface as nearly as may be, in order to reduce claims for drainages from abutting property owners, constitutes a study of what we may call the first cost of construction."

One of the points frequently lost sight of is the cost of maintaining the roadway after construction. That this has a direct relation to the established grade is clearly shown. The steeper the grade, the more will the surface be worn by the action of horses' hoofs, by the friction of the wheels when brakes are applied, and by "scour of water." "Another factor, and one of vital importance, is the cost of operation of a grade. This cost is a direct money loss, and one which increases with each year's increase of traffic and with each improvement of the road surface. Hence, a grade is properly determined only when the sum of the first cost, and of the capitalized cost of maintenance and of operation, is at a minimum, and should never be tolerated unless the capitalized extra cost of operation is less than the cost of changing to better conditions."

The cost of operating a grade depends, among other things, principally upon "the resistance to traffic on a level road. . . . ; the resistance directly due to the grade of the road . . . . ; the wear on harness, vehicle, and horse . . . . ; the effect of grade on time of travel . . . . ; and the difficulty of obtaining a foot-hold for horses on sloping surfaces." In the estimation of some of these factors of cost, there are minor factors that effect the final result; for instance, in estimating the resistance to traffic on a level road, the kind of vehicles to be used on it, the speed at which they are impelled, the material of which the road surface is made, and the average state of repair which will be maintained, all demand attention. Due consideration being given to all the elements which enter into the different factors in the cost of operating grades, Mr. Fuller evolves therefrom a general formula for what is appropriately styled the capitalized cost of grades. By the application of this formula accurate comparisons of cost can readily be made.

Engineers for Certain Public Offices.

OF the danger attending municipal control of any industry or engineering works, except those that provide for the supply of prime necessities of life,—such as potable water and drainage facilities,—an editorial in the *Engineering Record* for Dec. 15 is significant.

"At the present time, when the attention of appointing powers—no less than that of the public in general—is directed by recent political events of the better kind to the selection of candidates for public office on the score of fitness for the discharge of duties rather than capacity for politics, it is well to emphasize the correct meaning of 'fitness' for certain classes of official responsibility involving more or less engineering knowledge and experience. In every State, county, and city there are officials with whose functions the great mass of the people served are little or not at all acquainted in consequence of the technical character of the work they perform. It is only rational and barely consonant with a wise public policy that just in so far as the nature of such work is removed from common knowledge those who perform it should by their high professional and moral standing insure to the community at large faithful and efficient discharge of official responsibility. Abundant experience has shown that neither oath nor bond can be relied upon as a safeguard to take the place of a high professional reputation or efficiency attested by accomplished works. It is, or ought to be, superfluous to say that such a meritorious class of professional men do not usually seek offices, for the simple reason that private interests in the community seek them for the advantages accruing from their services."

The contrast between private business methods and those of municipal corporations in the selection of men to fill positions requiring expert qualifications is striking. In the one case the controlling factor is expertness in the functions to be performed, in the other it is political influence. Nor is there any immediate prospect that this can be changed. The history of the past shows that municipal governments are, to say the least, not getting better, even if, for the sake of argument, it be admitted that they are not getting worse. Much permanent improvement in the election of public officers in engineering departments of city works is not to be reasonably expected, so long as human nature remains what it is, and so long as political systems remain as imperfect as they are.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

Gas Supply.

*27170. Outdoor Lighting by the Incandescent Burner. F. G. Dexter, with Discussion (J G L-Nov. 20.) 4800 w.

*27508. Mr. Livesey on the Municipalization of Gas Supply (G W-Dec. 1.) 1200 w.

*27509. Inclined Retorts of the Leigh Gas Works. A. T. Fletcher, with Discussion (G W-Dec. 1.) 6000 w.

*27510. Prepayment Gas Meters. J. Nasmith (G W-Dec. 1.) 5500 w.

*27627. Prepayment Gas Meters as Sanitary Appliances (J G L-Dec. 4.) 2000 w.

27652. Gas as an Illuminant. Foree Bain (W. E-Dec. 15.) 900 w.

*27696. Thwaites Motor Gas Producer Plant (E R L-Dec. 7.) 1500 w.

27724. Benzole Carburetting Apparatus. Ill. (A M & I W-Dec. 14.) 1500 w.

27726. Ought the Guide Frame of a Multiple Lift Gas Holder Comprise the Upper Lift When Inflated to Full Capacity? A Discussion. David Leavitt Hough (P A-Dec. 15.) 2500 w.

27727. An Important Victory for the Welsbach Light.—Case of the Incandescent Gas Light Company vs. the Deimel Light Company, London (P A-Dec. 15.) 5500 w.

*27906. Improved Carburetted Water Gas Apparatus. Ill. (Inv-Dec. 15.) 2000 w.

*27997. A Small Experimental Plant as an Aid to the Management of a Coal Gas Plant. Peter Young (G W-Dec. 15.) 1400 w.

28077. Allen's Apparatus for the Manufacture of Gas. Ill. (A G L J-Dec. 31.) 2500 w.

*28126. Out-Door Lighting by the Incandescent Burner. F. G. Dexter (G E M-Dec. 10.) 1700 w.

*28127. Notes on Coin Meters. Frank Livesey (G E M-Dec. 10.) 1300 w.

28183. An Extensive Soft Coal Gas Apparatus. Ill. (P A-Jan. 1.) 1000 w.

We supply copies of these articles. See introductory.

28287. Liquid Fuel in Retort Houses. Ill. (A M & I W-Jan. 4.) 1600 w.

*28298. Radiometry and Photometry.—On the Work of H. O. Lummer and F. Kurlbaum (J G L-Dec. 25.) 1700 w.

*28299. Strains in Gasholder Guide Framing. M. Niemann (J G L-Dec. 25.) 900 w.

*28313. The Use of Flueless Stoves in Confined Rooms. Thomas Fletcher (G W-Dec. 29.) 900 w.

Sewage.

27601. Ventilating Subway Manholes by Sewer Connections. J. P. McQuaide (E R N Y-Dec. 12.) 600 w.

27829. Comparative Merits of Vitrified Pipe and Brick for Large Sewers (E N-Dec. 20.) 600 w.

28012. Sewer Construction in Boston, Mass. Ill. (E R-Dec. 22.) 2200 w.

28221. Test of Tightness of Cement Joints in Vitrified Pipe Sewers Made by Freeman C. Coffin. Ill. (E N-Jan. 3.) 3000 w.

Streets and Pavements.

27524. Roads and Carriages. Sterling Elliot (G R-Dec.) 7000 w.

27525. The Feasibility of McAdam Roads in Prairie Country. Horace G. Kauffman (G R-Dec.) 2300 w.

*27788. Street Grades and Intersections. William B. Fuller (J A E S-Nov.) 2000 w.

27822. Costs of Macadamizing Streets at Burlington, Vt. (E N-Dec. 20.) 2000 w.

*28195. The Benefits of Street Paving. George W. Shanklin (P-Jan.) 3000 w.

*28196. Highway Improvement in Massachusetts. Ill. Burton H. Allbee (P-Jan.) 1800 w.

28219. Portland Cement Pavements. G. W. Bartholomew, Jr. (E N-Jan. 3.) 800 w.

*28326. Street Paving and Hygiene. Editorial (Eng L-Dec. 28.) 2000 w.

Water Supply.

27505. Water-Pipe Repairs, St. John, N B. (E R-Dec. 8.) 1000 w.

*27579. The Water Supply of Towns (B-Dec. 1.) 2500 w.

27607. The Toronto and Hamilton Power and Water Supply Aqueducts—Are they Feasible Schemes? J. H. Killey (C Eng-Dec.) 1500 w.

27717. Steel Conduit Repairs, Toronto, Ont. Ill. (E R-Dec. 15.) 1600 w.

*27993. Water Purifying and Softening. (Abstract.) E. Brough Taylor (I C B-Dec. 14.) 1800 w.

28011. The Queen Lane Reservoir (E R-Dec. 22.) 4000 w.

28047.—75 cts. Experiment with Tube Wells at Lowell, Mass. George Bowers (J N E W-Dec.) 4200 w.

28048.—75 cts. What a Water Supply Engineer Can Do in the Fire Department. James E. Tryon (J N E W-Dec.) 4000 w.

28049.—75 cts. Notes on European Water Supplies. Allen Hazen, with Discussion (J N E W-Dec.) 8000 w.

28180. Changing the Suction System of a Pumping Engine. F. W. Dean. Read before A. S. M. E. (A M-Jan. 3.) 600 w.

28185.—$1.50. The Dunning's Dam, near Scranton, Pa. Ill. E. Sherman Gould, with Discussion (T C E-Nov.) 11500 w.

28264. Specifications for Riveted Steel Pipe, Cambridge, Mass. L. M. Hastings (E R-Jan. 5.) 1800 w.

Miscellany.

*27456. Municipal Cleansing and Public Health. George E. Waring, Jr. (E Mag-Feb.) 3000 w.

*27457. The Relations of Railways to Municipalities. Dwight Arven Jones (E Mag-Feb.) 3000 w.

27725. Tests of Building and Paving Bricks, with Editorial (E N-Dec. 13.) 2700 w.

27735. Engineers for Certain Public Offices. Editorial (E R-Dec. 15.) 800 w.

27824. The McKay Garbage Crematory at Yonkers, N. Y. Ill. (E N-Dec. 20.) 750 w.

27826. The Wrong Way to Conduct City Engineering (E N-Dec. 20.) 1500 w.

*27964. Sanitary Wash House at Glasgow. Ill. (E-Dec. 14.) 2300w.

28015. An Italian Public Wash-House. Ill. (E R-Dec. 22.) 900 w.

*28134. Old London Streets and Houses (A L-Dec. 21.) 1800 w.

28354. Parks and Park-planting. Editorial (G & F-Jan. 9.) 1600 w.

Serials.

23641. Details of Rural Water Supply (B-Began July 7—Ended Dec. 29—26 parts—30 cts. each).

24338. The Gas Engine (P A-Began Sept. 15—5 parts to date—15 cts. each).

24751. The Gas Manager Abroad (G W-Began Aug. 25—11 parts to date—30 cts. each).

26096. Notes on Modern Gas Making Plant (I & I-Began Oct. 12—Ended Dec. 7—6 parts—30 cts. each).

26221. The Manchester Thirlmere Water-Works. Ill. (Eng L-Began Oct. 19—3 parts to date—30 cts. each).

27272. The Construction of the New Syracuse Water Works. Ill. (E R-Began Dec 1—4 parts to date—15 cts. each).

27636. The Economic Principles of the Gas Producer (M W-Began Dec. 7—2 parts to date—30 cts. each).

27723. Gas-Holders. Ill. Herr Professor Pfeiffer (A M & I W-Began Dec. 14—Ended Dec. 28—3 parts—15 cts. each).

28028. The Report of the Dutch Committee on Photometry (J G L-Began Dec. 18—Ended Dec. 25—2 parts—30 cts. each).

28265. Frontinus on the Water Supply of Rome, A. D. 97 (E R-Began Jan. 5—1 part to date—15 cts).

RAILROADING

State Subsidies to Light Railways.

PROBABLY the reason for a more extended use of light railways in France than has yet been obtained in England is the fact that they have been helped by subsidies. *Transport*, quoting and translating from the *Voie Ferrée*, gives an account of the various forms of subsidies which have been adopted.

In one method, after "the lines are laid out and the cost estimated by the county engineers, this cost is estimated both per kilometer and for the entire line. The department, with the help of the State subsidy, makes itself responsible for the greater part of the expense. The companies who are inclined to bid for the concession examine the estimates and plans of the engineers, make their own calculations, and put in a tender in which they undertake: (1) To build the lines either for a price per kilometer, or for a lump sum which they put into their tender. In other words, they undertake to do the work at a certain discount off the price as estimated by the county engineer. (2) They offer to work at a certain price, which they also put into their tender in the form of a lump sum per kilometer, plus a definite percentage of the gross receipts."

The latter system is not approved. "Too often the department decides, not according to the business or financial capacity of the tenderers or their reputation, but according to the economies which it expects to make later on in the working expenses, —economies which probably will never be realized in practice. . . . Under this system the tenderers may very likely themselves be in error as to the probable earnings, and may undertake to do the work too cheaply, and it is quite likely that later on a working company will be compelled to abandon the undertaking to the very great injury of the department."

Another system—considered the best adopted up to the present time—is outlined as follows: "The construction costs are estimated by engineers as exactly as possible, and with the help of a schedule of prices, which takes a liberal view of the cost and of the interest of the constructing company. The company executes the works under the control of the county engineers on a schedule of prices, but with a fixed maximum for the line or lines included in the concession. The object of fixing a maximum sum is this: the accounts are settled after measuring up the work actually executed and charging them out at the schedule rates. If the result so arrived at is less than the fixed maximum, one-third of the difference goes to the department and the remaining two-thirds to the constructing company. If, on the other hand, the maximum is exceeded, the entire loss falls upon the company. In contracts drawn after this model, the department undertakes to bear the entire capital expense, and, in order to deter contractors or contracting companies who are untrustworthy, or with insufficient capital, from tendering, it has recourse to the following expedient: only three-quarters of the total expense are paid straight out; the remaining quarter is advanced by the contractor, and is either held as caution money or employed straight away on the works, being only paid by the department to the contracting company at the end of the concession. But during the whole time of the concession it bears interest at the rate of four per cent. The working company works at its own cost and risk. There is a fixed maximum for working expenses laid down in the concession. If this maximum is not attained, the working company receives as a premium two-thirds of the difference between the maximum and the actual expenditure. If the gross receipts are inferior to the maximum laid down for working expenses, the deficiency is carried to a suspense account. If the receipts are larger than the expenses, the balance is, in the first place, devoted to

paying the deficiencies carried to suspense account, with interest at four per cent., and, after this has been done, is divided equally between the department and the working company. This system has been adopted by two light railways recently sanctioned in the Department of the Loire. In that case the actual figures were as follows: As long as the receipts are less than three thousand francs per kilometer, the maximum for working expenses is fixed at the same figure. When the receipts exceed three thousand francs per kilometer, the maximum is fixed by the following formula:—

$W = 1450 \text{ fr.} + 0.02\ T + 0.20\ K + 0.30\ R.$

"In this formula W is working expenses, 1450 francs is the fixed payment per kilometer per annum, the third, 20 centimes per train kilometer, and the last item the percentage of the gross receipts less rates and taxes."

Certain precautions needed in any system of subsidizing are pointed out. Among these are guarding against an overestimate of earnings, making the railway as far as possible a high road, working it with the strictest economy, and avoiding a greater number of trains than the traffic imperatively calls for. The economic effect of subsidies upon the general welfare of a commonwealth is not discussed in its broader aspects; but, if the extension of light railways in agricultural districts requires this sort of aid, the advantages of the system are questionable.

Past and Present of Car-Ventilation.

IN line with what has been said about car-lighting, so far as it relates to the comfort and health of passengers, may appropriately be mentioned the subject of car-ventilation. Perhaps none of the minor problems of railroading have more obstinately resisted a satisfactory solution than this. One of the bottom difficulties is that there are always so many to satisfy, and, unless the progress of railway development evolves a kind of railway car wherein each passenger may travel by himself, and provided with means whereby he can breathe reasonably pure air or air mixed with as much carbonic acid as suits his individual taste, probably nobody will ever be satisfied with car-ventilation except theorists and visionaries. *Locomotive Engineering* for December editorially recalls the fact that "about twenty years ago the men representing the railroad car departments attempted to settle for all time the all exciting question of car-ventilation. That was a subject which had been familiar to railroad men ever since one passenger proceeded to open a car window while another person was protesting that the car was too cold already." About the time named there was a great deal said and done about car-ventilation, at least nine-tenths of which was waste effort.

"The Master Car Builders' Association was made the leading medium for exploiting the agitation. Elaborate reports were submitted to three successive conventions, and the whole subject was discussed from A to Z, and several times over again. The subject was discussed from the standpoint of the practical man, the scientist, the man who wants to be let alone in unhygienic comfort, and of the crank who insists that it is better to die of pneumonia than to violate nature's laws of cleanliness. There were learned opinions submitted concerning the nature of gases that contaminate the atmosphere of badly ventilated cars. The dreadful exhalations that exude from a crowded passenger car and the fearful disease germs that are disseminated when air is not circulated rapidly enough were pictured in a terror-inspiring manner. As the discussion waxed hot, the wonder grew that any person ever survived the ordeal of riding for a night in a badly ventilated car. Working in a sewer appeared a healthy occupation by comparison."

No wonder this cultivation of a field naturally fruitful produced a plentiful crop of ardently enthusiastic inventors, each of whom had not only the thing, but the very best thing needed to satisfy all parties. None of these things were difficult to manage; the only reason for not adopting them was purely and simply the parsimoniousness of railway managers, who, according to the unanimous testimony

of all disappointed inventors, have never been known to adopt any improvement unless compelled to do so by the pressure of public opinion.

"We cannot estimate the number of patented car-ventilators which were permitted to enjoy a brief popularity or were applied to cars on account of this agitation for fresh air, but there were a great many of them. The world notes not how the agitation died down, but it came quietly to an end, and the average car was not disturbed with improved ventilators. The clere-story sashes and the windows were still there, and those in charge waited till the clouds of reform rolled by, and they rolled without making many permanent changes."

Recently two long papers on car-ventilation were read at the New England Railroad Club. It is said that the gentlemen presenting their papers each had inventions in this line wherewith to solve the difficulties. The discussion called out by the papers occupied a good deal of time. The difference in the tone of discussion from that of the former boom period in car-ventilation is noticeable. "Then the speakers were noted for the positive views expressed as to how the thing should be done. There was no uncertainty about how the work should be carried out. Every man was positive that he knew all about car-ventilation. The only striking difference that we noted after a lapse of twenty years was that all the speakers not interested in a particular invention were extremely non-committal, some even going to the extent of admitting that they did not know anything about car-ventilation. To judge by this, our progress has been merely in the direction of letting people understand how difficult it is to change the air in a car quickly and regularly, and at the same time keep the inside warm enough to prevent people from catching cold."

No one yet has been able to show how a car can be thoroughly ventilated and warmed simultaneously without drafts and other objectionable features. The same would be true of a room in any building no larger than can be allowed for a passenger car, and which an equal number of people were compelled to occupy for hours together. The entrance of dust with air currents into cars may be overcome. When this is done, the two cases would be exactly parallel.

Improvement of Block Working.

MR. C. C. ANTHONY, in *The Railroad Gazette*, again calls attention to the fact that the "common American telegraph block system is not all the English block system, as it is often carelessly called; that the English system (aside from the Sykes) includes electric block instruments, which provides visible indications of 'line clear' and 'line blocked,' in addition to the information exchanged by the means of the electric bells. These indicators steadily exhibit the state of the road after permission has been given for a train to enter the block and while a train is in the block; at any moment information may be obtained from them at a glance. Indeed, they doubtless obtrude the information, and may be regarded as a silent and effective protest against errors that the signalman at either end of the block might make through forgetfulness, neglect to record certain movements, or failure to refer to his record before acting.

"The usual American arrangement of simple communication by bells or telegraph differs, then, distinctly from the English in the absence of these visual block indicators. But although the employment of such instruments on many American roads now using telegraph block would undoubtedly increase the efficacy of the block working, the same thing that stands in the way of the controlled manual system would come in here. Many roads that can gain much in safety by using the telegraph already at hand for block working could not, on account of the cost, provide an equipment of block instruments. In looking, however, for means of bettering the telegraph block, while too much can hardly be said of the need of thorough instruction and careful oversight of signalmen, another important difference between the American and the English should be

noted. The difference already noted is one of appliances. But more than that, the safety of block working in England is greatly enhanced by the use of carefully studied codes of rules and bell signals. Not only do some of the well-known lines have such codes, the equal of which would probably be found on few American lines, but already standard codes have been prepared. It may be imagined, however, that block working is rather a simple matter. Apparently a code of signals for communication between towers or stations could be written off in a few minutes. It would be easy enough to set down some numbers to be rung on the bells and to write opposite the numbers the information it should give; or a few abbreviations or numerical symbols could be provided for the telegraph. And as for the rules, the main thing is that a man should not admit a train to the block unless he knows that the block is clear, or until he has got the permission of the next man ahead; a few simple rules and instructions would be sufficient. Easy enough, surely. But when it is attempted to carry on block working with strictness and to provide for some of the many contingencies that constantly arise,—such as trains crossing over or going into or out of sidings, trains broken in two, trains without markers, trains backing into blocks, trains coupled together, and so on,—the simplicity of the work disappears. Indeed, a considerable experience on a road largely equipped with the Sykes system may justify the assertion that both the right arrangement of the bell or telegraph code and the provision of full and clear instructions are highly important." Improvements in signal codes are suggested, and the opinion advanced and seemingly justified that efficiency of block working on many American roads might be increased, without a materially appreciable increase of cost, by "improvement and enlargement of the codes of rules and signals for communication between block stations." The English codes are recommended as models from which suggestions of improvement may be derived for existing American codes, not yet worked out to perfection.

Railway Ties.

DISCUSSING "The Proper Length of Railway Ties," Mr. Jerry Sullivan, in the *Railway Review* (Dec. 8), finds it difficult to fix upon the origin of the standard 4 ft. 8½ in. railway gage, but seems to think it probable that "the original promoters of the railway adopted this gage in order to enable them to make use of the old Concord coaches or stages as passenger cars." However this may be, this gage has been found practicable and serviceable, and, unless some new and unexpected development in railway practice shall arise, the present standard gage is not likely to be departed from. Too many vested interests oppose any change, even if a change could be shown to be to some extent advantageous, which, in view of former experiments both with wide and narrow gages, is not probable.

The present length of ties—eight feet—does not seem so "immutably fixed." It is considered as "having been largely a matter of evolution, and, as it is asserted that the present length 'does not fully meet requirements,' this is considered a sufficient basis for supposing a change at some time in the near future may be demanded. A careful scrutiny as to the effect of passing trains on some railway track will disclose that each wheel of a passing train depresses the ends of the ties from one-fourth to one-half inch, depending on the size of the tie and the weight it supports. In order to be sure that this wavy motion does not come from the ballast, the observer may look under the ties after the train has passed, and it will be found that in no case do the ends touch the ground. This shows, of course, that the greater portion of the weight of trains is borne by a small ridge of ballast under the middle of the ties, and that the ballast under and outside of the rails affords a support only when the flexibility of the ties permits them to bend down far enough to rest on this ballast. This is known as a center-bound track, and is very destructive to ties, breaking them at their weakest point between the rails."

Swings and sags are also effects of a center-bound track. "These are primarily

caused by a weak spot in the ballast, or by several ties being laid together with the small ends all one way; and, the rail becoming low at this point, the cars tip sideways, and by their rebounding throw extra weight on the opposite rail, thirty to fifty feet further on, thus producing a series of low places alternately on each rail, making a very rough track." A remedy proposed and advised for this—an untamped strip of ballast midwise between the rails—is "about as bad as the disease, because during the rainy season untamped space under the center of the ties is liable to become filled with water, softening the roadbed and doing great damage to the track. So the trackmen are left to take either horn of the dilemma they please. If they tamp the center, the ends of the ties will work up and down under every passing wheel, like the rhythmic motion of piano keys under an adept's fingers; only, instead of discoursing sweet sounds, they belch forth a disgusting medley of mud, slush, and slime; while, if they do not tamp the centers, the mud will be found there."

From this it is argued that the ties ought to be of such a length as to support the same weight on the outside as on the inside of the rail; and, in order to effect this, the ties will need to be lengthened to ten feet, which would give a more stable track and require a less number of men for track service. The fact that such increase of length would practically increase by twenty-five per cent. one of the heaviest items in track maintenance is not mentioned. It is, however, asserted that the 8-ft. tie is not now giving satisfaction, and that increase in weight and speed of trains must soon compel a change in this detail of railway construction.

Franchises.

STARTING with the assumption that much confusion with reference to franchises exists in the minds of the public, Mr. R. D. Fisher in the *Street Railway Gazette* (Dec. 1) assigns as a reason for this lack of accurate conception, "a failure to keep pace with the law of corporations." Chief Justice Taney's definition of a franchise is quoted: "Franchises are special privileges conferred by government upon individuals, and which do not belong to the citizens of the country or community generally of common right. It is essential to the character of a franchise that it should be a grant from the sovereign authority, and in this country no franchise can be held which is not derived from a law of the State." Exclusive privileges thus granted are usually the inducement for men to organize corporations affording traveling and transportation facilities to the public. The vast network of American railways has been built by such corporations, working under such privileges, and—of scarcely less importance—the street railways for local traffic have been built in the same way. The instrument that shows such special privileges have been granted to a corporation is called a "charter." A privilege granted by a municipality, as, for instance, permission to a street-railway company to lay tracks in certain streets, is not a charter; it is a license; yet it is often in popular thought confused with the idea of a charter. In law the two things are of quite different effect, though each grants a privilege.

The only interest a street railway acquires in a street by reason of its franchise is "right of way," and this also has been, and its rights are, limited to the specific purpose for which the franchise or license or both is granted. "A license is simply a permission to do certain things. Hence a license or permission to occupy a street is not 'a special privilege or immunity' within the meaning of constitutional inhibitions. (See 31 Kan., 660, and Booth on Street Railways, 11.)" The question of most interest to the general public as regards street-railway franchises is what kind of streets or property is exempt from use by street-railway corporations, or subject to grant for this purpose. On this point it is asserted that the "consent by the State or municipal anthorities to occupy public highways for the construction, maintenance, and use of ordinary street railways is all that is necessary, and this, too, without compensation to abutting property owners. The recent decisions firmly up-

hold this doctrine of non-additional servitude. There is some conflict of opinion whether or not one company may appropriate the use of the right of way and tracks previously acquired and constructed by another; the weight of authority, however, is to the effect that such property may be taken."

A subject out of which much litigation has grown is the life of franchises. Of course a franchise may be limited by its own terms; but, when no limitation has been expressly stipulated or implied, it has been assumed that the franchise is perpetual. Most of the States have constitutionally inhibited the enactment of laws providing for the grant of irrevocable franchises; but, in the absence of these, "it is safe to assume that a State legislature may grant privileges exclusive in character and perpetual in duration; but a city has no such power without explicit legislative authority."

Mr. Fisher has compiled a list of street railways in the United States operating either under perpetual licenses or under very long terms, and they are more numerous than is generally supposed. Thirty-seven different roads are included in this list.

The Railway Year in Queensland.

"TRANSPORT" (Nov. 2) says that Queensland has suffered more from the recent commercial depression than any other colony in Australia. "Times have been bad in Melbourne, Sydney, and Adelaide, but colonists generally are agreed that in Brisbane they have been worse than anywhere. The colony had its boom, just as some of the others had, and over-speculation and commercial gambling on a gigantic scale did their work. The inevitable reaction set in, the more reckless of the adventurers went to the wall; and the more unstable of the trading concerns were swept out of existence; but, just as the commercial atmosphere was being purified, then came the disastrous floods, overwhelming the entire community in practical ruin."

It is significant of the strong character of the men who have peopled the colony that the government, banking institutions, and business men were able to bravely meet such a complication of disaster, and that "by the introduction of large and sweeping economies Brisbane has been able to keep its head above water."

Of course railway traffic took its share of this bitter medicine, and "the year's record, as a matter of fact, is discouraging." Some peculiar concomitants of railway operations in the Australian colonies are indicated in the following extract from the official report of the Railway Commissioners:

"We much regret that the 'Railway Border Tax Act' of 1893, which came into force on the 21st of July, 1893, has not had the effect of diverting to our lines the traffic from competitive areas in the south-western districts of the colony to the extent expected, notwithstanding the fact that we have considerably reduced the rates to a large number of the holdings. Two causes have operated against attaining the object in view. The carriers (teamsters and drivers of camel caravans) have largely reduced their rates for carriage to the New South Wales lines, and the New South Wales commissioners have followed their example."

Camel caravans as feeders of traffic to railway lines will seem strange to American readers. "Commissioners believe that the true solution of the difficulty will be found in the extension of the line from Charleville. This, it is thought, not only will secure to Queensland nearly the whole of the traffic which is now carried through New South Wales and South Australia, but will tend to develop the pastoral areas, and thus increase the traffic over existing lines. The frozen meat industry has not developed to the extent expected when the last report was issued, owing to the difficulty which has been experienced in obtaining steamers fitted with the necessary appliances for its conveyance, and partly owing to the fitful condition of the market in England for the commodity itself. Negotiations were being conducted in London by representatives of the freezing works in the colony with the view of regulating the supply and promoting the demand."

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated; W=Words.

RAILROADING.

25956. Street Railway Repairs. J. B. Cahoon (E W-Oct. 20.) 5000 w.

*26680. The Railway Year in Queensland (Tr-Nov. 2.) 1800 w.

27255. Franchises. R. D. Fisher (S R G-Dec. 1.) 2000 w.

*27270. Traction Engines. Editorial (Eng L-Nov. 23.) 1400 w.

*27284. The Past and Present of Car Ventilation (L E-Dec.) 1100 w.

*27455. The Railroad of the Future.—A Forecast of Coming Improvements. Theodore Voorhees (E Mag-Feb.) 3000 w.

*27457. The Relations of Railways to Municipalities. Dwight Arven Jones (E Mag-Feb.) 3000 w.

*27479. The Glasgow District Subway. Ill. (R W-Dec.) 5000 w.

*27480. The Congo State Railway. Ill. H. Conradi (R W-Dec.) 2000 w.

*27481. The Greathead Tunnel System Abroad (R W-Dec.) 1200 w.

*27482. A Sketch of Fare Checking (R W-Dec.) 3000 w.

*27483. Mail, Goods and Parcel Service on Tramways (R W-Dec.) 2000 w.

*27485. De Rechter's Radial Suspension for Railway Carriages and Tramcars. Ill. (Eng L-Nov. 30.) 1300 w.

*27490. Locomotives and Trains. Editorial (Eng L-Nov. 30.) 2000 w.

27597. The Proper Length of Railway Ties. Jerry Sullivan (R R-Dec. 8.) 1100 w.

27604. Car Construction and Decoration. Ill. Works of St. Charles Car Company (R C J-Dec.) 700 w.

27621. The Baltimore Belt Railroad. Ill. (R G-Dec. 14.) 2700 w.

27622. Annual Report of the Interstate Commerce Commission (R G-Dec. 14.) 3000 w.

27646.—75 cts. State Railways in Australia. William Hill (J P E-Dec.) 8000 w.

27649.—75 cts. State Aid to Railroads in Missouri. John Wilson Million (J P E-Dec.) 7500 w.

*27687. South Wales Railway and Dock Bills (Eng L-Dec. 7.) 2000 w.

27721. The National Disgrace of Train Robberies. Editorial (R A-Dec. 14.) 1500 w.

27738. A Modern Coal Handling Plant.—Lehigh Valley Coal Company. Ill. (R R-De 15.) 1000 w.

27740. Income Account of Railways in the United States (R R-Dec. 15.) 600 w.

27741. Grade Reductions. Editorial (R R-Dec. 15.) 1100 w.

27742. The Desirability of Freedom from Restriction in the Use of Box Cars (R R-Dec. 15.) 1000 w.

*27745. Light Railways—The Conference at the Board of Trade (Ry T-Dec. 8.) 14000 w.

*27786. Notes on the Brooklyn Elevated Railway of Brooklyn, N. Y. Ill. A. A. Stuart (J A E S-Nov.) 2700 w.

27827. Car Lighting by Storage Batteries in the Chesapeake and Ohio Railway (E N-Dec. 20.) 1400 w.

27835. The Physical Condition of Atchison (R G-Dec. 21.) 2800 w.

27836. The Decision in the Debs Case, with Editorial (R G-Dec 21.) 3000 w.

27837. The Street Railroads of New York. Ill. (R G-Dec. 21.) 2500 w.

27839. The Traffic Managers Doings in 1894 (R G-Dec. 21.) 1500 w.

27840. The Accident in the Chicago Cable Tunnel (R G-Dec 21.) 900 w.

*27849. Cast-Welding Rail Joints—A Promising Rival of Electric Welding. Ill. (S R R-Dec.) 1800 w.

*27851. Personal Injury Accidents—The Management of Employés, with Reference Thereto. By a Superintendent (S R R-Dec.) 2500 w.

*27852. The Model Plant of the Fairhaven and Westville Railroad, New Haven, Conn. (S R R-Dec.) 900 w.

27900. Prussian Railway Reform. H. K. White (R R-Dec. 22.) 1200 w.

27901. Continuous Rails by Cast Welding. Ill. (R R-Dec. 22.) 1200 w.

27903. Railway Manufacturing. Editorial (R R-Dec. 22.) 1200 w.

27904. The Right to Route Passengers. Editorial (R R-Dec. 22.) 900 w.

27930. Rapid Transit. C. Wellman Parks (E W-Dec. 29.) 1000 w.

27936. The A. R. U. Leaders Found Guilty. Decision of Judge Woods in the Contempt Case Against E. V. Debs and Associates (R A-Dec. 21.) 4000 w.

*27944. American Railway Securities in Germany (B T J-Dec.) 1500 w.

*27951. Great City Railroads. Robert I. Sloan (Ch-Jan.) 3500 w.

*27960. Express Locomotives for Liquid Fuel. Ill. (E-Dec. 14.) 2200 w.

*27961. Light Railways. Editorial (E-Dec. 14.) 3800 w.

*27967. "Eighty-Four Miles an Hour." Charles Rous-Marten (Eng L-Dec. 14.) 5000 w.

28044. The Latest Plan for a New York Rapid Transit Railway. Ill. (E N-Dec. 27.) 1400 w.

*28062. The Prospects of Electric Traction (E E L-Dec. 21.) 2300 w.

*28100. Electric Traction.—Discussion of

Papers Read Before the Institution of Electrical Engineers (E–Dec. 21.) 3000 w.

28125. Engineer Parsons' $66,000,000 Rapid Transit Plan for New York City (E R N Y–Jan. 2.) 900 w.

28137. The Harper's Ferry Improvement of the Baltimore and Ohio Road. Ill. (R A–Dec. 28.) 1000 w.

*28138. Block Signaling. Ill. W. H. Elliott (L E–Jan.) 2000 w.

*28139. Railway Machinery in Great Britain. Ill. A. S. (L E–Jan.) 1600 w.

*28141. Edison Car Shops. Ill. (L E–Jan.) 2000 w.

28161. Tunneling under London.—The Waterloo and City Electric Railway. Ill. (E N Y–Jan. 2.) 800 w.

28167. The New Compound Locomotives of the Paris-Lyon-Mediterranean Railway. Ill. Ch. Baudry (R R–Dec. 29.) 1000 w.

28168. Reasonable Railway Rates. H. T. Newcomb, with Editorial (R R–Dec. 29.) 2200 w.

28169. Operation of Railroad Stock Yards. Editorial (R R–Dec. 29.) 900 w.

28170. The Right to Collect Excessive Back Charges. Editorial (R R–Dec. 29.) 1400 w.

28186.—$1.50. Railroad Signaling.—The Block System. Ill. John P. O'Donnell, with Discussion (T C E–Nov.) 22000 w.

†28199. The System of the People's Traction Company, Philadelphia. Ill. (S R J–Jan.) 6500 w.

†28200. Double Truck vs. Single Truck Cars. Ill. John A. Brill (S R J–Jan.) 2200 w.

†28201. Street Railway Wheel Flanges. Ill. (S R J–Jan.) 1500 w.

†28202. The Perfect Wheel (S R J–Jan.) 1800 w.

†28203 Behavior of Wheels on Rails (S R J–Jan.) 2000 w.

†28204. Street Railway Experience in Denver. Ill. C. K. Durbin (S R J–Jan.) 2000 w.

†28205. The New Power Station of the Consolidated Traction Company of New Jersey. Ill. (S R J–Jan.) 1200 w.

†28206 Rails and Special Work; Their Method of Manufacture. Ill. (S R J–Jan.) 2400 w.

*28209. The Pennsylvania Railroad's Columbian Exhibit. Ill. (N C B–Jan.) 1000 w.

28217. Track Laying by Machinery, with Editorial (E N–Jan. 3.) 4500 w.

28218. Some Recent Fenders for Street Cars. Ill. (E N–Jan. 3.) 800 w.

28220. The Latest Decision in Air-Brake Patent Litigation (E N–Jan. 3.) 1500 w.

28248. The Hungarian Railroads. (Abstract.) A. E. Ziffer (R G–Jan. 4.) 1000 w.

28249. Compressed Air in Railroad Shops. Ill. F. M. Wilder (R G–Jan. 4.) 1300 w.

28250. Employees' Tickets in England. C. H. G. (R G–Jan. 4.) 1100 w.

28260. The New Power Station of the Lindell Railway Company, St. Louis. Ill. (W E–Jan. 5.) 2000 w.

28262. Transporting and Handling a Sixty Ton Cable. Ill. (E R–Jan. 5.) 2500 w.

28275. The Electric Street Railway Car Controller. Anon. (E W–Jan. 5.) 1200 w.

28279. About Specifications—Shall They Be Strict or Lax? Editorial (R E M–Jan.) 800 w.

28302. The Relation of Railways to Industrial Prosperity. W. C. Brown, with Editorial (R R–Jan. 5.) 4800 w.

28303. The History of the "Bogie Truck" as Applied to Locomotives. Clement E. Stratton (R R–Jan. 5.) 1500 w.

*28323. The Railways of New South Wales. C. (Eng L–Dec. 28.) 2000 w.

*28327. The Meigs Elevated Railway System. Ill. (Eng L–Dec. 28.) 2500 w.

28335. European Street Railways—From the N. Y. Sun (S R G–Jan. 5.) 1600 w.

28363. Electric Railway Development in Northern Ohio.—The Street Railway Systems of Cleveland and Vicinity (E R N Y–Jan 9.) 1200 w.

Serials.

17826. Evolution of the Air Brake. Ill. Paul Synnestvedt (R E M–Began Dec. 1893—12 parts to date—15 cts. each).

18435. Painting a Railway Passenger Car. A. Ashmun Kelly (R E M–Began Jan., 1894—9 parts to date—15 cts. each).

24586. Railway Companies and Their Employés (R A–Began Aug. 24—7 parts to date—15 cts. each).

24621. Rules and Instructions for the Guidance of Railway Agents (R R–Began Aug. 25—19 parts to date—15 cts. each).

25670. Special Shop Tools. Ill. (R E M–Began Oct.—4 parts to date—15 cts. each).

26400. Railroad Legislation and National Prosperity. Don Alexander (R G–Began Nov. 2—3 parts to date—15 cts. each).

27091. The Manchester and Sheffield Railway Extension to London. Ill. (E–Began Nov. 16—Ended Dec. 21—3 parts—30 cts. each).

27364. State Subsidies to Light Railways (Tr–Began Nov. 23—2 parts to date—30 cts. each).

27603. A Treatise on the Construction of Railroad Rolling Stock. A. Flamanche, A. Huberti and A. Stewart (R C J–Began Dec.—1 part to date—15 cts).

27850. What Street Railways Can Learn from Steam Roads. Ill. (S R R–Began Dec.—1 part to date—30 cts).

27905. The Electric Braking of Motor Cars. Ill. W. Nelson Smith (S R G–Began Dec. 22—Ended Dec. 29—2 parts—15 cts. each).

28101. Light Railways. J. Walwyn White (E–Began Dec. 21—Ended Dec. 28—2 parts—30 cts. each).

28304. Signals and Signaling. Anon. Ill. (R R–Began Jan. 5—1 part to date—15 cts).

We supply copies of these articles. See introductory.

SCIENTIFIC MISCELLANY

Peach Culture in Belgium.

THE *Journal of the Society of Arts* has printed an interesting article on the culture of peaches in Belgium, which draws largely from a recent report of the U. S. Consul at Liege for its facts, and which demonstrates the importance, now thoroughly recognized in scientific horticulture, of the practice of budding a variety of fruit trees upon a more hardy and a vigorous stock of kindred tree, thus enabling the weaker scion to be successfully grown where otherwise nothing but failure could be expected. The facts with reference to the practice are not in themselves new to horticulturists, or unfamiliar to American readers of horticultural papers. The principle is extensively practised in ornamental and landscape gardening. For example, some varieties of roses are obtained in much greater perfection through budding them upon hardier stock than would be possible were the parent stock alone relied upon. The results attained in Belgium in the growth of peaches, by the use of this method, showing how far it can be carried, and how profitable it can be made, together with methods of preventing injury by frost, are interesting. After supplying a population of 500 to the square mile, Belgium annually exports about 105,000,000 pounds of fruit, the value of which is $2,904,000, a large proportion of this exportation being peaches. What is remarkable about this is that seedling peaches grow and produce very feebly in Belgium.

"In fine soil and in situations protected from the north and north-east winds, peach trees grown from the seed have occasionally borne fruit; but, to ascertain the best stock upon which to bud, a long series of experiments were tried upon all the varieties of prune, apricot, sweet and bitter almonds—every tree, indeed, of a kindred nature—till the conclusion was reached that the best stem for grafting was the red plum. This hardy plant, whose roots spread wide and strike deep, imparts much of its own vitality to its foster scions. Grafting or budding is done out of doors, so as not to soften the young tree by accustoming it to unnatural conditions. The next question to be considered was that of soil. In sandy and dry earth it was found that neither the tree or the fruit flourished, the one being spindling and the other small; while in rich and moist alluvial soil the tree prospered at the expense of the fruit. A calcareous soil, neither wet or dry, is preferred by the peach, the young trees requiring a great deal of lime. As it is impossible to tell, without chemical analysis, the exact amount of this element contained in any given quantity of earth, its application must be more or less experimental. The rule in Belgium is to first thoroughly fertilize the soil with manure, and then, after planting the tree, to add a peck of lime to every cubic yard of earth, placing it near the surface. As it is necessary to loosen the earth for at least 6 feet square and 3 feet deep, this quantity —a bushel to a tree—may seem large, but the authorities are all agreed that more rather than less would be better. The application should be repeated every three years."

The method of espalier culture has succeeded better than the standard trees, but the sunny sides of walls and buildings are now preferred. Peach trees with dwarf stems not more than twelve inches high, and with branches six feet long, spreading fan-like over an extent of southern wall, and loaded with fruit, are one of the commonest sights in Belgium. The prolific growth of fruit thus attained is astonishing. On four of these dwarf trees growing on a surface of about 30 feet square, 2300 good-sized peaches were counted. The modes of protecting these growths from frost, to which they are much exposed at the time of flowering, are the placing among the upper boughs of the tree branches cut from other trees; or, what is less generally preferred and practised, the

covering of the trees with mosquito netting, which, while it admits light and air, has proved a sufficient protection. With reference to the rationale of these methods, the object of either of them is to retard the flowering till such a time as the buds may open with safety from injury by frost; and it is added that the method must be used with caution, as too much shade is apt to injure the germs by excluding the rays of the sun.

"The old custom of using closely-woven cloth, like table or bed linen at night, and removing it in the morning, is said to be more dangerous than the frost itself, as the trees at this season cannot be deprived of air without serious injury. In addition, this artificial heat at night, succeeded by the warmth of the sun, hastens their blowing, when the object is to delay it as long as possible. Shading at night is sometimes as essential as covering at night. The poor succeed very well in protecting their fruit by placing a number of horizontal poles about 18 inches apart, and from 4 to 6 inches from the trees, and covering them with light wisps of straw. In good situations, penthouses will sometimes suffice to protect the fruit; in any case they are extremely useful in checking the flow of sap. Since 1876, the following addition to this method has made assurance doubly sure: A fringe, made of unthreshed rye straw by tying the cut ends of the stalk together with twine or cord, six or eight in a loop, with spaces of about 3 inches between the wisps, is attached to a pole and suspended under the eaves of the penthouse and in front of the trees. The texture being open, it does not prevent the light and air from reaching the buds. These shields are usually placed in position about the 1st of March, and are not removed except in cloudy weather, until all danger has passed."

These facts are suggestive to American horticulturists of the amateur sort. In this country the culture of the peach has migrated, the tendency being toward milder climates. The results are an increase in size and a deterioration in the flavor of this delicious fruit, which, like the apple, seems to obtain its greatest perfection of flavor in the highest latitudes where its cultivation is practicable.

Mysteries of the Ruby.

PROBABLY no gem ranks higher in popular estimation than the ruby when found in highest perfection, which is not so frequently the case as might be supposed. A variety of gems are sold as rubies which are not such, though in some measure resembling the true ruby. The latter is not only extremely beautiful as a gem, but it is of great scientific interest, presenting yet unsolved problems as regards its physical structure and its color.

Prof. Judd, in a recent lecture before the Royal Institution, London, discussed the mysteries that yet cluster around this gem, the most perfect specimens of which are found in Burmah. An abstract of the lecture is printed in the *Australian Mining Standard* (Nov. 3).

"The chief scientific interest of the ruby corundum flows from the extraordinary peculiarities of structure that it presents, as well as from the mysterious qualities that determine its striking color. It is found in crystals of a great variety of shapes, but all having a tendency to the peculiar habit of growth known to crystallographers as 'twinning.' By testing crystals of corundum with polarized light, its structure is found to be wonderfully complex, and under the microscope its exterior face is covered with a strange network of sculpture, indicative of molecular changes."

But there are other points of scientific interest. The true ruby is "pure, limpid, fiery red corundum,"—chemically, crystallized aluminum oxid. This substance also forms other highly prized gems, as the sapphire, emerald, aqua marine, etc. The true ruby is second in hardness only to the diamond. In its mass it nearly always incloses some foreign substance. A curious fact is "that these included bodies lie generally disposed in planes meeting each other at an angle of sixty degrees, the result being to produce the phenomenon of asterism, which is the term given to the white star of light which is observable on certain jewels cut with a rounded surface. Very frequently the imprisoned body is a

minute bubble of gas or drop of liquid, containing sometimes little crystals of its own. The microscopic cavities containing these things are often very numerous. For a long time the nature of the gas and fluid contained in the cavities remained a mystery. The English philosopher, Brewster, was induced to investigate the subject by hearing that a ruby which an Edinburgh jeweller had placed in his mouth had exploded while in that position with unpleasant results. Other investigations followed, and it has now been made certain that the fluid is no other than liquid carbonic acid gas, reduced to that condition by great pressure."

The color of this mineral is due to its action on light, which, in the true ruby, has all its rays absorbed, except the red, which passes freely through the crystal. That the variety of color is due to differences in molecular structure is shown by the fact that the different examples of the same chemical substance absorb and transmit different rays. How this proves difference in molecular structure is shown in all comprehensive treatises on physics. "The color is distributed most irregularly, and some corundum crystals show in patches the tints of the ruby, the sapphire, and the emerald all mixed up together. These colors are, of course, due to the special way in which the structure of the crystal deals with the light passing through it, the ruby absorbing all the rays except those which emerge to give it its characteristic color. How greatly these colors depend on molecular and chemical changes going on in the crystal is obvious from the strange way some gems behave under light and heat. Prof. Maskelyne mentions a diamond which, when taken out of the warm pocket and allowed to cool on the table, turned a beautiful red. Prof. Judd startled his audience by declaring that the green glass panes used in the conservatories at Kew gradually changed through various shades of yellow to a distinct purplish hue under the prolonged action of light. Rubies change their color in a curious way under the action of heat. Bluish rubies turn perfectly green, and on cooling regain their original tint. The blue sapphire turns white, and the yellow corundum crystal becomes green. Then there is the strange property of 'Pleo-chroism' in the ruby family and its kindred; they exhibit different tints according to the side of the crystal you are examining. Some amorphous powdered oxid of aluminum was placed in a vacuum tube and subjected to the electrical discharge from a high-tension coil. It was shown that the white powder glowed with the brilliant red of the ruby, and that the glow continued after the discharge ceased,—a fact which seems a curious confirmation of the ancient idea that rubies would glow for a time in the dark. The same experiment was repeated with a variety of corundum stones, artificial rubies, etc., to show the greater or less degree of ruby glow exhibited by each."

The ruby has been imitated artificially, and the artificial product is scarcely inferior in color and general appearance to the natural gem, at least to the majority of stones sold as rubies; but art has not been able to imitate the other physical peculiarities described, nor has science yet been able to discover the natural methods by which they are created.

Automatic Mercury Vacuum Pump.

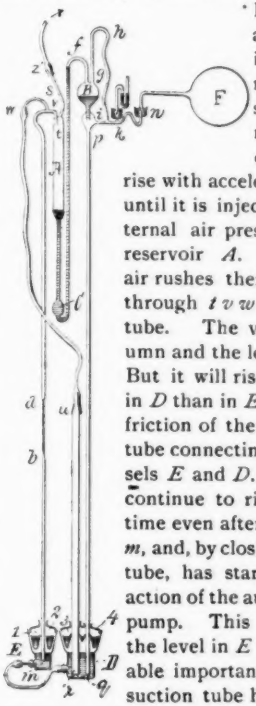
M. I. PUPIN, Ph. D., Columbia College, in the January number of *The American Journal of Science*, describes a new form of mercury vacuum pump devised by him, which, it appears, ought to be more rapid in its operation and decidedly more convenient than vacuum pumps hitherto used for laboratory purposes. It employs no cocks whatever, and thus avoids one of the most annoying appurtenances of any apparatus wherein a vacuum is to be maintained. All who are familiar with the use of the "Sprengel" pump will probably concede the superiority of this apparatus, in which a suction pump is combined with a Sprengel pump. The degree of vacuum obtainable is the same as that produced with the Sprengel pump.

That part of the device which acts as a suction pump consists of a reservoir *A*, to which is joined the "suction-tube," *t v m*. A short branch tube, *v w*, is connected by

a rubber tube, *w u*, to the wide tube, called the "valve-tube." The suction tube dips into a mercury vessel, *E*, and the valve-tube into a similar vessel, *D*. These vessels contain glass dishes 1, 2, 3, 4, "holding sulphuric acid for drying purposes," and are connected with each other by a rubber tube. The part *a b* of the suction tube has a cross-section, half the size of that of the rest of the tube.

B is the reservoir of the Sprengel pump, and *p q* the "tube of descent." A convenient length for this tube is one hundred and sixty centimeters. A lateral extension, *g h i*, equalizes the gas pressure above and below the mercury in the reservoir. The ground joints *k* and *n* are made air-tight by mercury contained in hoods, as shown. A siphon-barometer connection between *A* and *B* consists of a bulb *c* and a tube *c f*. The entire apparatus is of glass, except the rubber tubes.

"First a little mercury is poured through *z s* into *A* until the reservoir *c* is about half full, which is considerably more than sufficient to fill the tube *c f*. By means of a rubber tube, *z s* is connected then to a water-pump or any suction pump that may be available. Suppose that this auxiliary suction pump is capable of reducing the pressure in *A* to say forty millimeters, and suppose also that the barometric pressure is seven hundred and sixty millimeters. Owing to the action of the auxiliary suction pump, the gas pressure in *A* is continually reduced, and therefore also in *F* and in all other parts connected with *A*. Mercury rises in the valve and suction tubes, and also in the tube of descent. The extremity *m* of the suction tube is placed at such a distance below the initial level of the mercury in *E* and *D* that, when the mercury column in the suction tube is about sixty centimeters long, the mercury level in *E* (which sinks rapidly on account of the rising of the mercury into the valve tube) has just reached *m*. From that moment on, no more mercury gets into the suction tube. But, owing to the action of the auxiliary pump, the pressure in *A* is being still reduced; hence the column in the valve tube rises still higher, and the level in *E* sinks lower. In the meantime the column in the suction tube rises bodily, owing to the external air pressure, until it reaches the narrow part *a b*, when it begins to lengthen out; and, since *a b* is twenty centimeters long and the initial of the mercury column is sixty centimeters, it follows that this column will be lengthened out to seventy centimeters and no more.



Hence, as soon as the pressure in *A* has been reduced by seventy centimeters, this column will rise with accelerated velocity until it is injected by the external air pressure into the reservoir *A*. The external air rushes then into *A* and through *t v w* into the valve tube. The valve-tube column and the level in *E* rise. But it will rise more rapidly in *D* than in *E* owing to the friction of the narrow rubber tube connecting the two vessels *E* and *D*. Hence it will continue to rise for a short time even after it has reached *m*, and, by closing the suction tube, has started again the action of the auxiliary suction pump. This retardation of the level in *E* is of considerable importance; for, if the suction tube had no contraction *a b*, and if the two levels in *E* and *D* were continually of the same height, then the mercury would be sucked up through the suction tube, not in form of solid columns, but in form of numerous drops separated from each other by air-bubbles. This would render the rapidity of action less satisfactory; besides, it would also cause a rapid oxidation of the mercury.

"As soon as the quantity of mercury injected into *A* brings the distance between the level in *A* and the point *f* into the vicinity of the barometric height, then the mercury begins to overflow from the siphon tube into the reservoir *B*, and the exhausting of *F* begins. By squeezing the

tube connecting *E* and *D*, the rapidity of supply to *B* is varied; hence the quantity of mercury in *B* can thus very easily be kept within certain desirable limits."

Instruction of the U. S. Army Signal Corps.

SINCE the weather signal service was transferred to the Department of Agriculture, about two years ago, the army signal corps has been trained in its duties at Fort Riley, Kansas. The course of instruction, as we are told by George Heli Guy in *The Electrical Engineer* (Dec. 12), occupies six months, "and consists of both theoretical and practical instruction in electricity, topography, photography, signaling instruction to operators, and practice with the field telegraph and balloon trains. The practical course of electricity covers the ordinary laboratory measurements of E. M. F., current and resistance, and location of faults in telegraph wires; the construction, use, and repair of ordinary telegraph and telephone instruments; and the construction and maintenance of telegraph and telephone lines. The course in topography and photography includes rapid sketching and reconnaissance work, and the ordinary photographic operations—printing and enlarging; the application of photography to map-making is extensively used, and the camera is employed effectively in the captive balloon. The various systems of signaling and cipher are explained, and practice extends over various ranges up to 12 miles, with the flag, heliograph, torch, and flash lantern; and with the field telegraph kit, using both insulated cable and the bare wire system. The course of instruction to operators consists largely in practice with the Morse system until each of the sergeants can send and receive 35 words a minute on the typewriter, together with the regulations for transmission of messages and keeping the accounts of the various military lines, on which a considerable work is done.

"The means of communication by day used by the corps are flags, heliograph, and the field telegraph and telephone trains; and by night the torch, flash-lanterns, rockets, bombs, and searchlight. The method of visual signaling by flags consists in waving a flag to the right for a dot, to the left for a dash, and to the front for the space in the American Morse code. The heliograph, in brief, consists of a combination of mirrors by which a beam of sunlight is thrown in the required direction, and the dots and dashes of the Morse code are made by the opening and closing of a shutter placed in the track of the beam of sunlight. The heliograph has been used recently by the Corps up to a distance of 182 miles. At night the Morse code is sent either by the waving of a torch or flashes of light from the flash-lantern, a new type of which has been recently designed, of light weight, small size, and high penetrating power, the illuminant being coal oil, which is always available. It is the intention of the chief of the Corps to have a searchlight train — the plans for which have already been prepared — as soon as congress, in its inscrutable wisdom, shall begin to realize the necessity of preparing for war in time of peace."

An illustrated account of various appliances follows. The subjects of the illustrations are the heliograph; field telegraph train; outpost cable cart and telephone kit; signal balloon; erection of a field telegraph line; and the balloon wagon employed in balloon signaling and reconnoitering. The extent to which both electricity and aeronautics now aid in military operations is indicated by this paper, which in popular style clearly describes in detail the duties and operations of the signal corps, as systematically taught at Fort Riley.

The Fuel of the World.

THE animal, vegetable, and mineral kingdoms each furnish a greater or less share of the world's fuel. But the mineral sources of supply are now, and have been during the greater part of the present century, of far greater importance. A writer in the *Globe-Democrat*, quoted in *Progressive Age*, has gathered some interesting facts relating to the subject. Numerous patents for so-called artificial fuels have been procured. Corncobs saturated with petroleum, grasses and weeds com-

pressed into blocks, and other organic materials and mixtures of organic with mineral substances figure in these patents. A large number of patents have been granted for utilization of coal dust, and a variety of materials for admixture with pulverized coal, and for holding it compacted into lumps or briquettes, have been employed. Among these materials are clay, molasses, sawdust, Irish moss, asbestos, lime, resin, cut straw, chaff, petroleum waste, peat, clam shells, charcoal from garbage, corn meal, wheat flour, sugar, seaweed, broken glass, lard, tar, forest leaves, and waste cork cuttings. This does not exhaust the list by any means.

The waste of many industries is utilized as fuel, either by itself or mixed with other kind of fuel. In most wood-working establishments the waste cuttings are so used, and in the shoe manufacturing towns leather cuttings are said to form a large proportion of the fuel used by the poorer classes for domestic purposes. In many localities in the West maize has been largely used as fuel, and it makes a rousing fire. On the great Western plains "buffalo chips," the dried dung of the buffaloes, have cooked many a dinner for weary travelers. In Egypt, mummies; in British Columbia and among the Eskimau, oil, blubber, and inedible muscular fiber,—make fires for the people. Even the bodies of certain birds unsuitable for food, but rich in fat, are said to supply this need on the coast of Scotland.

Chemical products furnish ideal, though comparatively expensive, fuel. Alcohol is one of these much used in the arts. giving a pure, hot, smokeless flame, which renders its use almost indispensable in some delicate operations. The principal products of all practically available fuels, of whatever nature, are water and carbonic acid. If the fuel contains more hydrogen than carbon, water is the larger product. The burning of pure hydrogen in oxygen produces water only. The water passes off as steam, and is absorbed by the surrounding air. If, on the other hand, the fuel consists wholly or largely of carbon, carbonic acid gas is produced; and, unless the supply of oxygen is sufficient, many fuels give off a large amount of unconsumed carbon, either as carbonic oxid, or in the form of black smoke.

Lardarelo Boric Acid Works.

THESE works are situated in northern Italy, near the town of Monte Carboli, and were established in 1818. Mr. Wm. P. Mason has recently described them in a paper read before the Baltimore section of the American Chemical Society, giving an account of the natural sources of the boric acid and of the methods of obtaining and refining it. The district abounds in numerous fumaroles, the steam issuing from which contains boric acid to the amount of one-tenth of one per cent. These fumaroles have been tubed, mostly with 8-inch pipe. Besides the natural orifices, artificial fumaroles have been bored down to the steam zone, like artesian wells. The steam is discharged into cisterns of spring water, from which the boric acid solution is piped into settling basins to remove muddy sediment. Thence the solution passes into large leaden evaporating pans and is concentrated. It is next removed into crystalizing tanks, from which the crystals of boric acid are removed by wooden scoops, drained in baskets, and spread upon a steam-heated drying floor. The mother liquor is reconcentrated. About 200 hands are employed, and the annual product—about 1700 tons—is shipped to England.

The New Gas.

THE supposed new chemical element whose discovery was announced by Lord Rayleigh at the Royal Institution in August, 1894, is likely to prove a subject of much debate. Prof. Dewar, whose opinion will certainly have much weight in the scientific world, especially upon a point such as the existence or non-existence of any previously undetected body in the earth's atmosphere, has expressed doubt that the supposed new gas is anything except an allotropic form of nitrogen. Prof. Dewar's reasons for this surmise, and the difficulties which accompany the supposition that it is a chemical element existing to the extent of one per cent. in ordinary atmo-

spheric air, were given in the *New Science Review* (Oct.) under the title "The New Element of the Atmosphere."

The avidity with which the public receives any statement of an alleged new discovery at the present time has led many other publications to announce this hitherto unknown substance—whatever it may prove to be—as undoubtedly a new element, and it may prove to be really such. But when men of Prof. Dewar's caliber still doubt, it is better to defer positive expressions of opinion, and wait for confirmative evidence.

INDEX TO LEADING ARTICLES.

The journals quoted are indicated by initials, and their full titles are given in the opening pages of the Review. Other abbreviations are, Ill=Illustrated W=Words.

25800. The Lardarelo Boric Acid Works (Sc A S-Oct. 13.) 700 w.

†26921. "The New Element of the Atmosphere."—Considered by Professor Dewar (N S R-Oct.) 1000 w.

*27467. Lamp Accidents. Editorial (Iry-Oct.) 400 w.

*27486. Peking (Eng L-Nov. 30.) 2200 w.

*27519. Engineers of To-day—and Yesterday. James Reid—Thomas Williamson. Ill. (E Rev-Nov. 20.) 900 w.

*27526. Experiments in Aeronautics. Ill. Hiram S. Maxim, with Discussion (J S A-Nov. 30.) 6300 w.

27529. European Bottle Glass. Robert Linton (A M & I W-Dec. 7.) 900 w.

†27543. Sketch of Dr. John Locke. Ill. N. H. Winchell (A G-Dec.) 4800 w.

†27544. The "Slate Binders" of the "Pittsburg" Coal Bed. W. S. Gresley (A G-Dec.) 3300 w.

†27545. Springs: The Influence of Stratigraphy on Their Emergence, as Illustrated in the Ozark Uplift. Ill. T. C. Hopkins (A G-Dec.) 1000 w.

†27546. The Age of the Crystalline Limestones of Warren County, New Jersey. Lewis G. Westgate (A G-Dec.) 3400 w.

†27547. Geological History of the Missouri Paleozoic. G. C. Broadhead (A G-Dec.) 2800 w.

*27556. The Germans and Classical Archæology (A L-Nov. 30.) 2300 w.

*27571. Testing Wines (C T J-Dec. 1.) 2000 w.

27629. The Signal Corps of the United States Army: Instruction Work at Fort Riley, Kansas. Ill. George Heli Guy (E E N Y-Dec. 12.) 3500 w.

†27640. The Carrying Trade of the World. Michael G. Mulhall (C R-Dec.) 1800 w.

†27641. Mountain-Falls. W. M. Conway (C R-Dec.) 3000 w.

†27642. Contributions to Our Knowledge of the Genus Cyclus from the Carboniferous Formation of Various British Localities. Ill. Henry Woodward (G M-Dec.) 3000 w.

†27643. Physiographical Studies in Lakeland. J. E. Marr (G M-Dec.) 2500 w.

†27644. Notes on the Geology of Western Australia. Harry P. Woodward (G M-Dec.) 2700 w.

†27645. On the Application of the Sand-Blast for the Development of Trilobites. Ill. H. M. Bernard (G M-Dec.) 1500 w.

†27666. A Threatened City—Pekin. M. Rees Davies (F R-Dec.) 4000 w.

*27691. What Is Gravity? Ill. R. C. Shettle (E E L-Dec. 7.) 4000 w.

27712. Calcium Carbide and Acetylene. Francis Wyatt (E M J-Dec. 15.) 2300 w.

27729. The Fuel of the World (P A-Dec. 15.) 2000 w.

†27734. Discussion in New York of Prof. George D. Shepardson's Paper—"Suggestions for an Index of Engineering Literature" (T A I E E-Dec.) 11500 w.

*27736. Fire Protection. Edwin O. Sachs, with Discussion (J S A-Dec. 7.) 13000 w.

*27771. Technical Education. Address of Mr. Waterhouse (I C B-Dec. 7.) 2600 w.

*27775. Mysteries of the Ruby (A M S-Nov. 3.) 1100 w.

*27776. The Origin of Kerosene Shale. John W. Rock (A M S-Nov. 10.) 1500 w.

*27789. On the Composition of the Ohio and Canadian Sulphur Petroleums. Charles F. Mabery, with Discussion (J A E S-Nov.) 4500 w.

†27791. Engineering Fallacies. Address of Henry Morton (S In-Oct.) 8800 w.

27817. Phosphorescence and Photographic Action at the Temperature of Boiling Liquid Air. James Dewar (Sc A S-Dec. 22.) 1200 w.

27825. The Force Exerted by Tornadoes (E N-Dec. 20.) 900 w.

27828. Recent Tests of Smokeless Powders (E N-Dec. 20.) 2000 w.

27833. Big Trees "of California" Found Fossilized in Colorado. A. Lakes (M S P-Dec. 15.) 1700 w.

*27925. A New Platinum Standard of Light (J G L-Dec. 11.) 2000 w.

*27946. Changes in the Customs Tariff of Guatemala (B T J-Dec.) 2000 w.

*27947. Customs Tariff of British Guiana (B T J-Dec.) 1500 w.

*27948. Tariff Changes and Customs Regulations. Sweden, Russia, Denmark, Switzerland,

France, Spain, Italy, Roumania, Chili, Japan, United States, Guatemala, Brazil, British India, Jamaica and Cape Colony (B T J-Dec.) 5000 w.

*27950. The World's Debt to Chemistry. H. B. Cornwall (Ch-Jan.) 6000 w.

*27998. The Manufacture of Salt. Thomas Ward (J S A-Dec. 14.) 9500 w.

*28000. Professor Victor Meyer's New Method of Determining High Melting Points. A. E. Tutton (N-Dec. 13.) 900 w.

*28029. A Systematized Photometrical Nomenclature (J G L-Dec. 18.) 3300 w.

†28037. A New Flying Machine. Ill. Hiram S. Maxim (C M-Jan.) 5200 w.

*28069. Engineers of To-day—and Yesterday. William Arrol. Ill. (E Rev-Dec.) 1000 w.

*28073. The Engineering Industries of Glasgow.—Descriptions of Leading Works. Ill. (E Rev-Dec.) 10800 w.

†28089. Late Glacial or Champlain Subsidence and Reëlevation of the St. Lawrence River Basin. Warren Upham (A J S-Jan.) 7500 w.

†28090. On Graphical Thermodynamics. René de Saussure (A J S-Jan.) 7500 w.

*28092. Mr. Bryce's New Chapters on Current American Questions. Albert Shaw (R of R-Jan.) 4500 w.

*28118. The Broader View. G. W. Dickie (I S F-Jan.) 4400 w.

*28132. Forestry. J. Michael, with Discussion (J S A-Dec. 21) 14000 w.

*28146. Glass Historically Considered. Anon. (I C B-Dec. 21.) 2200 w.

*28149. Gilding Glass. Anon. (I C B-Dec. 21.) 1000 w.

28176. Practical Measurement of the Velocity of the Wind (Sc A S-Jan. 5) 1000 w.

†28184. An Automatic Mercury Vacuum Pump. Ill. M. I. Pupin (A J S-Jan.) 800 w.

†28187. On Electrosynthesis by the Direct Union of Weak Organic Acids. J. B. Weems (A C J-Dec.) 6500 w.

†28188. Pentosans in Plants. G. de Chalmot (A C J-Dec.) 6300 w.

†28189. On Chemical Equilibria as Temperature Functions. J. E. Trevor and F. L. Kortright (A C J-Dec.) 2500 w.

†28190. A New Formula for Specific and Molecular Refraction. W. F. Edwards (A C J-Dec.) 1700 w.

†28194. Carborundum; Its History, Physical Properties and Chemistry. John Alexander Mathews (S M Q-Nov.) 1800 w.

*28212. On the Problem of Aerial Navigation. William Bosse (A E R J-Jan.) 1300 w.

*28213. Hydrogen Gas Apparatus for the United States Signal Service. Ill. (A E R J-Jan.) 1200 w.

*28214. Voyage of the Balloon "Svea" at Stockholm, Sweden, Oct. 19, 1893. H. G. Hazen (A E R J-Jan.) 900 w.

*28215. "Soaring" Experiments. Ill. A. M. Herring (A E R J-Jan.) 1000 w.

†28234. A Review of Stereo-Chemistry. Stewart Woodford Young (J F I-Jan.) 3200 w.

28261. Thermal Storage. Ill. Nelson W. Perry (W E-Jan. 5.) 5500 w.

*28331. On the Relative Frequency of Different Velocities of Wind. William Ellis (C G-Dec. 28.) 900 w.

*28346. On a Remarkable Earthquake Disturbance Observed at Strasburg, Nicolaiew, and Birmingham on June 3, 1893. E. Von Rebeur-Paschwitz (N-Dec. 27.) 3000 w.

*28353. Explosives and Their Modern Development. Vivian B. Lewes (J S A-Dec. 28.) 7000 w.

†28364. An Investigation of the Twitchell Method for the Determination of Rosin in Soap. Thomas Evans and I. E. Beach (A C J-Jan.) 2400 w.

†28365. Vulcanization of Small Hard Rubber Specialties. John T. Usher (I R W-Jan.) 1200 w.

†28366. American Rubber Erasers by the Ton. Gustav Heinsohm (I R W-Jan.) 1000 w.

†28367. The Insurance of Rubber Factories (I R W-Jan.) 900 w.

†28368. Official Statistics of India-Rubber and Gutta-Percha (I R W-Jan.) Table.

Serials.

21763. Engineering Practice and Education. Gaetano Lanza (J F I-Began May—9 parts to date—45 cts. each).

22848. Physical Units. Magnus McLean (E E L-Began June 8—10 parts to date—30 cts. each).

24462. Graphic Statics. W. W. F. Pullen (P Eng-Began Aug. 10—10 parts to date—30 cts. each).

25885. Engineering Lectures. Walter M. McFarland (Eng-Began Oct. 13—6 parts to date—15 cts. each).

26996. Statically Indeterminate Structures and the Principle of Least Work (E-Began Nov. 9—3 parts to date—30 cts. each).

27198. Refrigeration and Ice-Making (S E-Began Nov.—2 parts to date—15 cts. each).

27548. Constructive Engineering on the Pacific Coast. Ill. (I S F-Began Dec.—2 parts to date—30 cts. each).

27586. Cathode Rays. E. E. Brooks (E R L-Began Nov. 30—Ended Dec. 14.—2 parts—30 cts. each).

27922. The Nature and Use of Industrial Explosives. J. Daniel (C G-Began Dec. 14—2 parts to date—30 cts. each).

27959. Ferdinand de Lesseps (E-Began Dec. 14—Ended Dec. 28—3 parts—30 cts. each).

28001. Endowment for Scientific Research and Publication. Addison Brown (N-Began Dec. 13—Ended Dec. 20—2 parts—30 cts. each).

28231. The Animal as a Prime Mover. R. H. Thurston (J F I-Began Jan.—1 part to date—45 cts).

28263. The Handling of Men. Foster Crowell (E R-Began Jan. 5—1 part to date—15 cts).

We supply copies of these articles. See introductory.

NEW BOOKS OF MONTH

ARCHITECT, OWNER AND BUILDER BEFORE THE LAW. A Summary of American and English Decisions on the principal questions relating to building, and the employment of architects, with about 800 references, including also, practical suggestions in regard to the drawing of building contracts and forms of contracts suited to various circumstances. By T. M. Clark, Fellow of the American Institute of Architects. New York: Macmillan & Co., 1894. [8vo., 387 pp. Price, $3.]

THE purpose of this book is to relieve as much as possible the difficulties experienced by parties to controversies relating to building, resulting from ignorance of the legal principles underlying the various questions likely to arise in the execution of building contracts. The relation of the architect to the owner, the architect's duties to his employer, the position of the architect in cases when the cost exceeds the limit, the responsibility of the architect for his own work, the architect's authority as an expert, the authority of the architect acting as agent for the owner, architects' claims to compensation, architects' commissions, complications arising from sickness or death of the architect, the ownership of plans, the relation of the architect to the builder, the authority of the architect over the builder, architects' certificates, and the whole subject of contracts relating to building are treated, and the principles laid down are sustained by the citation of a large number of cases recorded in law reports.

THEORY AND PRACTICE OF DESIGN. An Advanced Text Book on Decorative art, being a sequel to the author's, "Lessons on Decorative Design." By Frank C. Jackson, Lecturer on Principles of Ornament, Advanced Design, and teacher of Technical Art Processes, etc., in the Birmingham Municipal School of Art. 700 illustrations. London: Chapman & Hall, Ltd. Philadelphia: J. B. Lippincott & Co., 1894. [8vo., 216 pp. Price, $2.50.]

A MORE advanced treatise than "Lessons on Decorative Design," previously written by the same author, this book ought to share the great popularity which the earlier work received. It is not a mere collection of designs, but an analytical, thorough-going exposition of the principles of design. Its tendency is, therefore, not toward a school of bald imitation, but toward originality in conception and execution. The great number of well executed illustrations amply exemplify the principles laid down.

PRAY'S STEAM TABLES AND ENGINE CONSTANTS. For facilitating all calculation upon indicator diagrams of various problems connected with the operation of steam engines, from reliable data, and with precision. Compiled from Regnault, Rankine and Dixon, directly, making use of the exact records. By Thomas Pray, Jr., C. C. and M. E., Member of many Societies, &c. New York: D. Van Nostrand & Co. London: E. & F. N. Spon, 1894. [8vo., iv-85 pp. Price, $2.]

THESE tables, prepared by an engineer of extensive experience, are the result of a well-directed effort to bring together in a single volume, all necessary data for computations in testing steam engines, and, so far as relates to motive power of steam, all data required in designing steam engines to develop from a definite rate of fuel consumption, a definite amount of power. Accuracy and convenience have been the leading aims of the work. To this end every table has been computed, and nothing has been copied. Rankine and Regnault are accepted as the highest authorities. Each table is supplied with explanatory text, and there has thus been embodied in compact and convenient form the data most used in boiler tests, computations of duty performance of pumping engines, and analysis of indicator diagrams.

TRANSACTIONS OF THE ASSOCIATION OF ENGINEERS OF Cornell University. Volume II, 1893-1894. Containing addresses by non-resident lecturers, miscellaneous papers, constitution and by-laws of the Association. Ithaca, New York. [Pamphlet, 8vo., 140 pp. Price $1.]

BESIDES the president's annual address, this volume contains a lecture delivered by Clemens Herschell of New York, before the engineering students of Cornell University, February 2nd, 1894, on "Frontinus and his II Books on the Water Supply of the City of Rome A. D. 97." Also notes of certain field methods used on the Sur-

vey of the Mexican boundary in 1892 and 1893. By John F. Hayford, C. E., Assistant Astronomer International Boundary Survey U. S. and Mexico, and some notes on fire protection engineering, by John R. Freeman, Civil Engineer, Boston, Mass. The latter paper is profusely illustrated with examples of so-called fire-proof standard slow burning mill construction, examples of combustible architecture, roof construction, construction of floors, and details relating to building with the express view of resisting combustion.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. By Sylvanus P. Thompson, D.S.C., B.A., F.R.S., F.R.A.S., Principal of and Professor of Physics in the city, and the Guilds, of London, Technical College, Finsbury; late Professor of Experimental Physics in University College, Bristol. New Edition. Revised throughout with additions. New York: Macmillan & Co., 1895. [12 mo., 628 pp. Price $1.40.]

THE name of the author of this book would be in advance a full guarantee of its worth to those familiar with his works, and having knowledge not only of his attainments as a scientist, but also of his ability as an instructor. They would expect, and would find the book to be fully up to date as to its facts, to be as comprehensive as is possible in such an elementary treatise, and to present the whole subject in most perspicuous style. Although originally published in 1881, the book has been largely re-written to bring it fully abreast with the great advancement of electrical science during the intervening thirteen years. The style of printing and the illustrations are excellent. A full table of contents is supplemented by a copious index, and a collection of problems and exercises rounds out and complete the treatise.

MODEL ENGINE CONSTRUCTION. WITH PRACTICAL INstructions to Artificers and Amateurs. By J. Alexander. Containing numerous illustrations and twenty-one working drawings from original drawings by the author, and re-drawn by C. E. Jones, New York: Whitaker & Co., 1894. [12mo, 324 pp., price $3.00.]

THIS book is more especially designed as an aid to amateur constructors of model steam engines, with their boilers and fittings, including stationary, locomotive, and marine engines, model railways, and railway cars. Also some instructions are given in the art of pattern-making, and the book concludes with directions for constructing a hot-air engine. As the construction of models of machinery is good mechanical training, the book will be useful for students and apprentices in mechanical engineering.

RENAISSANCE AND MODERN ART. By WILLIAM H. Goodyear, M. A., Lecturer on History of Art in the Cooper Institute, Brooklyn Institute and Teachers' College. Author of "Ancient and Modern History," "A History of Art," "The Grammar of the Lotus," "The Roman and Medieval Art," etc., etc. Flood & Vincent. The Chautauqua Century Press, Meadville, Pa., 1894. [12mo, 310 pp., bound in buckram, coated paper, gilt top, edition *de luxe*. Price $2.00.]

THIS is a book that ought to be in the library of every student of art, to whatever branch he may be devoted, whether architecture, sculpture, or painting. One of its best features is its numerous references to the best works for art students to peruse, making it an admirable guide to art literature. It contains two hundred and ten engravings, executed from photographs taken by permission of artists and owners from works in their collections.

ELECTRIC RAILWAY MOTORS. THEIR CONSTRUCTION, Operation, and Maintenance, and Elementary Practical Handbook for those engaged in the Management and Operation of Electric Railway Apparatus, with Rules and Instructions for Motormen. By Nelson W. Perry, E. M. New York: Street Railway Gazette Co. 1894. [12 mo., 288 pp., Price, $1.00.]

THIS is a re-publication in book form of a serial first printed in the *Railway Gazette*. The purpose of the book, which seems well carried out, is to place before motormen and switchmen an exposition of the principles involved in the use of the motors employed by them in their occupation, of which they often have very meagre and imperfect notions. The treatise has been prepared with direct reference to its adaptation to this class of men, and is, therefore, free from technicalities, except such as cannot be avoided in any treatise upon this subject.

PROCEEDINGS OF THE INTERNATIONAL ELECTRICAL CONgress, held in the City of Chicago August 21-25, 1893. Published by the American Institute of Electrical Engineers, 26 Cortlandt street, New York, U. S. A., 1894. [Oct., 488 pp., Price, $3.00.]

THE International Electrical Congress at the Columbian Exposition was one of the most important international congresses held in connection with the great

Fair, in respect both to the scientific standing of those who took part in it, and to the character of its proceedings. Very rarely in the history of the world has such a galaxy of intellect been gathered for the advancement of a single scientific cult. As was anticipated, the proceedings make a book of far more than usual interest and importance. The portraits of the official delegates, grouped in an admirable frontispiece, and the standard abbreviations adopted by the congress and printed at the end of the volume, are alone worth the price of the book.

PICTURES OF THE FUTURE. AN EXPERIMENT IN A MODEL Social World and What Came of It. By Eugene Richter, Member of the Imperial German Parliament. Translated from the German by Amos Nurgesser Titus. New York: Optimus Printing Co., 1894. [12 mo., 190 pp., paper. Price 50 cents.]

ONE of the Paragon Library Series. The author, having set his imagination free to form a vision of the state of society that would result from the triumph of social, istic principles, assumes that he himself is a socialist, and pictures the disappointments, heart-burnings, and sorrows experienced by himself and his family in their unsuccessful attempts to adapt themselves to their new environment. They are represented as finding everything very remote from the felicity which the new regime was expected to bring to every member of the community. A comical as well as satirical picture is painted of the public cook-shops-children's homes, refuges for people of advanced years, the new currency, and the other institutions that accompanied the new social status. In short, the book is a sharp-edged satire upon the fallacies of the Socialistic scheme.

BOOKS RECEIVED.

Office of Naval Intelligence, General Information Series, No. XIII.=Information from abroad. Notes on Year's Naval Progress. July, 1894. Navy Department, Washington. [458 pp., paper covers.]

The State Agricultural College, Fort Collins, Colorado.=Agricultural Experiment Station Bulletin No. 27. 3d Edition, revised, of Bulletin No. 13. The Measurement and Division of Water. Approved by the Station Council, Alston Ellis, president.

Watts, W. L., M.E., Assistant in the Field.= The Gas and Petroleum Yielding Formations of the Central Valley of California. Sacramento State Office: A. J. Johnston, Superintendent State Printing, 1894. [Pamplet. 8vo., 100 pp.]

Storms, W. H., Assistant in the Field.= Methods of Mine Timbering. Sacramento: State Office: A. J. Johnston, Superintendent State Printing, 1894. [Pamphlet. 8vo., 54 pp.]

Washington: Government Printing Office.= Annual Report upon the Improvement of Harbors on Lake Ontario, east of Oak Orchard, New York, in charge of Dan. C. Kingman, Capt., corps of engineers, U. S. A.: Being Appendix P P of Annual Report of the Chief of Engineers for 1894. [Pamphlet. 8vo. 44 pp.]

Hight, G. A., Deputy Conservator of Forests, Bombay.=Report on Forest Administration in Germany. Calcutta: Office of the Superintendent of Government Printing, India, 1894. [Pamphlet. 8vo. 18 pp.]

Pew, Arthur.=Notes on Government Railroads. [Pamphlet. 68 pp. Price 35 cents.]

Fifth Annual Report of the Board of Public Works of Kansas City, Mo.=For the fiscal year ending April 16, 1894. Kansas City, Mo.: Lawton & Burnett, printers, 1894. [Pamphlet. 8vo. 103 pp.]

Fish, J. C. L., C. E., Assistant Professor of Civil Engineering in the Leland Stanford, Jr., University.=Lettering of Working Drawings. New York: D. Van Nostrand Co., 1894. [Quarto, 13 plates, presenting a great variety of styles copied from good samples of lettering on actual working drawings, &c., and 9 pages of text, all printed on heavy coated paper. Board, price, $4.00.]

NEW TRADE CATALOGUES.

These catalogues may be had free of charge on application to the manufacturer.

Babcock & Wilcox Co., 29 Cortlandt St., New York, U. S.A.=Steam, its Generation and Use. With Catalogue of the Manufactures of the Babcock & Wilcox Co., 8vo., 182 pp., 28th Edition. [The number of editions this book has passed through is sufficient evidence of its value and rank in the literature of steam-engineering. Its reliability as a guide to the best steam practice has never been disputed, and its popularity is constantly increasing. It will be understood that, while the catalogue of the firm that publishes it is a feature of the work, a large proportion of it is occupied by a thorough-going treatise upon the manufacture and construction of boilers, and their operation, and the applications of steam to power and heating purposes. The information given is entirely up to date.]

W. J. Johnston Co., Ltd., 253 Broadway, New York, U. S. A.=Catalogue, unpaged. [Enumerating and describing a large number of electro-technical works of character and standard value.]

For additional catalogues see Improved Machinery, page 38.